EPA/ROD/R04-00/074
2000

EPA Superfund
Record of Decision:

JACKSONVILLE NAVAL AIR STATION
EPA ID: FL6170024412
OU 03
JACKSONVILLE, FL
09/28/2000

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

SEP 28 2000

4WD

Commanding Officer
Naval Air Station Jacksonville
Jacksonville, Florida 32215-5000

SUBJ: Final Record of Decision
Operable Unit Three
EPA ID# FL6 170 024 412

Dear Captain Turcotte:

The United States Environmental Protection Agency (EPA) has reviewed the Department of the Navy's Final Record of Decision (ROD) for Operable Unit 3 - Potential Sources of Contamination (PSC) 11, 12, 13, 14, 15, 16 and 48, Building 780 and Other Areas of Elevated groundwater Contamination at Naval Air Station Jacksonville pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended. EPA concurs with the findings and the selected remedy presented in this ROD.

Sincerely,

Richard D. Green
Director
Waste Management Division

cc: David B. Struhs, Secretary
Florida Department of Environmental Protection

Captain Richard E. Cellon, USN, Commanding Officer
Southern Division Naval Facilities Engineering Command

RECORD OF DECISION

POTENTIAL SOURCES OF CONTAMINATION 11, 12, 13, 14, 15, 16, AND 48, BUILDING 780, AND OTHER AREAS OF ELEVATED GROUNDWATER CONTAMINATION

OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA
UNIT IDENTIFICATION CODE: N00207
CONTRACT NO.: N62467-89-D-0317/146

SEPTEMBER 2000

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA 29418

Harding Lawson Associates
Engineering and Environmental Services
2533 Greer Road, Suite 6
Tallahassee, Florida 32301 - (850) 656-1293

RECORD OF DECISION

POTENTIAL SOURCES OF CONTAMINATION 11, 12, 13, 14, 15, 16, AND 48, BUILDING 780, AND OTHER AREAS OF ELEVATED GROUNDWATER CONTAMINATION

OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

Unit Identification Code: N00207

Contract No.: N62467-89-D-0317/146

Prepared by:

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2533 Greer Road, Suite 6
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Prepared for:

Department of the Navy, Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Dana Gaskins, Code 1857, Engineer-in-Charge

September 2000

CERTIFICATION OF TECHNICAL
DATA CONFORMITY (MAY 1987)

The Contractor, Harding Lawson Associates, Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0317/146 are complete and accurate, and they comply with all requirements of this contract.

DATE: September 20, 2000

NAME AND TITLE OF CERTIFYING OFFICIAL: Phylissa Miller
Task Order Manager

NAME AND TITLE OF CERTIFYING OFFICIAL: Willard Murray, Ph.D., P.E.
Project Technical Lead

(DFAR 252.227-7036)

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of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
ARARs	applicable or relevant and appropriate requirements
bls	below land surface
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIPP	cured-in-place pipe
COC	contaminant of concern
CSF	cancer slope factor
DCE	dichloroethene
DNAPL	dense nonaqueous-phase liquid
DPT	direct-push technology
EE	engineering evaluation
EE/CA	Engineering Evaluation and Cost Analysis
ELCR	excess lifetime cancer risk
EPC	exposure point concentration
ERA	ecological risk assessment
FDEP	Florida Department of Environmental Protection
FGFFC	Florida Game and Freshwater Fish Commission
FNAI	Florida Natural Areas Inventory
FOTW	Federally-Owned Treatment Works
FSWS	Florida Surface Water Standards
ft/day	feet per day
ft/year	feet per year
HI	hazard index
HLA	Harding Lawson Associates
HQ	hazard quotient
HRC™	hydrogen release compound
IRAs	Interim Removal Actions
IROD	Interim Record of Decision
$KMnO_4$	potassium permanganate
LNAPL	light nonaqueous-phase liquid
LUCs	land-use controls
lb	pound
MCL	maximum contaminant level
MOA	memorandum of agreement
Fg/kg	micrograms per kilogram
Fg/R	micrograms per liter
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram a day

GLOSSARY (Continued)

mg/ℓ	milligrams per liter
MNA	monitored natural attenuation
MnO_4^-	permanganate ion
NADEP	Naval Aviation Depot
NAS	Naval Air Station
NAPL	nonaqueous-phase liquid
NCP	National Oil and Hazardous Substances Contingency Plan
NFRAP	No Further Remedial Action Planned
O&M	operation and maintenance
OU	Operable Unit
OSHA	Occupational Safety and Health Administration
PAHs	polycyclic aromatic hydrocarbons
PCE	tetrachloroethene
PSC	potential source of contamination
PVC	polyvinyl chloride
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
SVE	soil vapor extraction
TAL	target analyte list
TBC	to be considered
TCE	trichloroethene
TCL	target compound list
TOC	total organic carbon
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UV/OX	ultraviolet light and oxidation
VC	vinyl chloride
VOC	volatile organic compound

1.0 DECLARATION OF THE RECORD OF DECISION

1.1 SITE NAME AND LOCATION. The site name is Operable Unit (OU) 3, which contains Potential Sources of Contamination (PSCs) 11 (Building 101), 12 (Old Test Cell Building), 13 (Radium Paint and Disposal Pit), 14 (Battery Shop), 15 (Solvent and Paint Sludge Disposal Area), and 48 (Dry Cleaners - Building 106) located at the Naval Air Station (NAS) Jacksonville in Jacksonville, Florida. In addition, PSC 16 (Black Point Storm Sewer Discharge), which is located adjacent to the OU, has been investigated and assessed concurrently with OU 3 and is included as part of this Record of Decision (ROD).

1.2 STATEMENT OF BASIS AND PURPOSE. This decision document presents the selected remedial actions for OU 3, NAS Jacksonville. The selected actions were chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP). The information supporting these remedial action decisions is contained in the Administrative Record for OU 3, which is located at Southern Division Naval Facilities Engineering Command in North Charleston, South Carolina. The information repository, which also contains the supporting documents for these remedial action decisions, is located at the Charles D. Webb Wesconnett Branch of the Jacksonville Public Library in Jacksonville, Florida.

The U.S. Environmental Protection Agency (USEPA) and the State of Florida concur with the selected remedies as outlined in this document.

1.3 ASSESSMENT OF THE SITE. Actual or threatened releases of hazardous substances from groundwater at OU 3 or sediment at PSC 16, if not addressed by implementing the response actions selected in this ROD, may present a current or potential threat to public health or welfare or the environment.

1.4 DESCRIPTION OF THE SELECTED REMEDY. OU 3 is one of three OUs at NAS Jacksonville. Remedies have been executed according to signed RODs for both OU 1 and OU 2. Contamination requiring remedial action at OU 3 consists of nine groundwater plume hot spots (Areas A, B, C, D, E, F, and G, PSC 48, and Building 780), a small area of sediment contamination at one storm water outfall (PSC 16) and a small section of the storm sewer. The cleanup strategy for OU 3, which is consistent with the overall site management plan for NAS Jacksonville, is to address the media posing the greatest risk to human health and the environment first. The overall strategy emphasizes cleanup remedies which ultimately minimize the need for land-use controls (LUCs) or other administrative controls.

Source materials constituting principal threats are thought to exist at two of the groundwater hot spot areas; PSC 48 and Building 780. Ongoing Interim Removal Actions (IRAs) are addressing these contaminated areas using treatment technologies (i.e., air sparging with soil vapor extraction and carbon sorption at PSC 48, and groundwater extraction and treatment with soil vapor extraction and catalytic oxidation at Building 780).

The preferred cleanup actions for OU 3 consist of the two ongoing IRAs; enhanced biodegradation for Areas C and D; *in situ* chemical oxidation for Area F; monitored natural attenuation (MNA) for Areas B and G; and selective removal of tar balls for PSC 16. Contamination of water within the storm sewer system is thought to be caused by the groundwater plume at Area F. It is expected that the cleanup action for the Area F groundwater will also clean up the storm sewer water. Therefore, the remedy for the contamination of the water in the storm sewer will be to monitor the water quality after cleanup of the Area F groundwater. If contamination remains in the storm sewer water after the Area F groundwater is clean, the cured-in-place pipe (CIPP) alternative will be implemented to completely seal the inside of the storm sewer pipe to eliminate contaminated groundwater infiltration. These cleanup remedies are intended to address the risks at those areas.

In addition, natural attenuation was also the preferred selection for Areas A and E; however, additional data collection and evaluation was deemed necessary before final remedies could be selected for these two areas. Therefore, the final cleanup methods for Areas A and E are NOT part of this ROD, and will be chosen at a future date.

The major components of the preferred cleanup actions are the following:

- continuing operation of the two IRA systems at PSC 48 and Building 780, as described in the Engineering Evaluation and Cost Analysis (EE/CA) (ABB Environmental Services, Inc. [ABB-ES], 1995b);

- implementing enhanced biodegradation, using hydrogen release compound (HRC™) injected into the aquifer to passively release lactic acid as an electron donor, to stimulate biological destruction of the volatile organic compounds (VOCs) in the groundwater hot spots at Areas C and D;

- implementing *in situ* chemical oxidation by recirculating an oxidant through the plume areas using extraction and injection wells at Area F;

- implementing the MNA alternative, which consists of periodic monitoring of the natural attenuation processes (e.g., biodegradation, dispersion, dilution, sorption, and volatization) at Areas B and G;

- physically removing tar balls from the upper six inches of sediment by using a raking device at the PSC 16 storm water outfall area;

- monitoring groundwater and storm sewer water, implementing and maintaining LUCs and groundwater use restrictions, and conducting five-year site reviews.

In addition to PSC 48, there are five other PSCs within OU 3. The preferred remedial action at PSCs 11, 12, 13, 14, and 15 is No Further Action because of the following:

- An IRA was completed at PSC 11 to remove the tankage, pipes, building structure, flooring, and contaminated soil associated with the former plating shop. Based on the risk assessment, there is no longer unacceptable risk to human or ecological receptors from contamination at PSC 11.

- A risk evaluation conducted at PSC 12 has shown that contaminants within the soil are within both State and Federal regulatory limits and do not pose an unacceptable risk to human health or the environment.

- Since the radium contaminated soil and dials have been removed from PSC 13 there is no longer a risk to humans or ecological receptors. Furthermore, the site has been cleared for unrestricted use by the U.S. Navy Radiological Affairs Support Office.

- Based on risk evaluations, the soils at PSCs 14 and 15 do not pose an unacceptable risk to humans or the environment under both current and projected future land use (industrial). Land-use controls will be implemented at both locations to limit future activities at these PSCs.

1.5 STATUTORY DETERMINATIONS. The remedial actions identified in this ROD are protective of human health and the environment, comply with Federal and State applicable or relevant and appropriate requirements (ARARs), and are cost effective. These remedies also utilize permanent solutions to the maximum extent practicable for the sites. The selected remedies for groundwater contamination also satisfy the statutory preference for treatment as the principal element of the remedy (i.e., reduce the toxicity, mobility, and volume of contaminants throughout the treatment process). However, the selected remedy for contaminated sediment at PSC 16 may not satisfy the statutory preference for treatment since the tar balls (the source of the contamination) will be raked and removed. Following removal, the tar balls will be tested to determine the treatment required to meet statutory disposal criteria.

Because the groundwater treatment remedies will initially result in hazardous substances remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after commencement of the remedial actions to ensure that the remedies continue to provide adequate protection of human health and the environment.

1.6 ROD DATA CERTIFICATION CHECKLIST. The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file for this site.

Record of Decision Data Certification Checklist

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Information	Section(s)	Page(s)
Chemicals of concern and their respective concentrations.	2.7	2-30 through 2-40
Baseline risk represented by the chemicals of concern.	2.7	2-38 and 2-42 through 2-45
Cleanup levels established for chemicals of concern and the basis for these levels.	2.9	2-55 through 2-61
How source materials constituting principal threats are addressed.	2.11	2-89 and 2-90

Record of Decision Data Certification Checklist

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Information	Section(s)	Page(s)
Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of ground water used in the baseline risk assessment and Record of Decision.	2.6	2-26
Potential land and groundwater use that will be available at the site as a result of the selected remedies.	2.6	2-26
Estimated capital, annual operation and maintenance, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.	2.9, 2.12	2-66 and Tables 2-30 through 2-36
Key factor(s) that led to selecting the remedies	2.12	2-90, 2-92, 2-97, 2-103, 2-104

1.7 SIGNATURE AND SUPPORT AGENCY ACCEPTANCE OF THE REMEDIES

S. A. Bagby CAPT acting
Captain S. A. Turcotte
Commanding Officer, NAS Jacksonville

9/25/00
Date

2.0 DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION. NAS Jacksonville is located in Duval County, Florida, on the western bank of the St. Johns River (Figure 2-1). OU 3 is located in the eastern part of the installation adjacent to the St. Johns River (Figure 2-2). The official mission of NAS Jacksonville is to provide facilities, service, and managerial support for the operation and maintenance of naval weapons and aircraft to operating forces of the U.S. Navy as designated by the Chief of Naval Operations. Some of the tasks required to accomplish this mission include operation of fuel storage facilities, performance of aircraft maintenance, maintenance and operation of engine repair facilities and test cells for turbojet engines, and support of special weapons systems.

OU 3 contains PSC 11 (Building 101), PSC 12 (the Old Test Cell Building), PSC 13 (the Radium Paint Disposal Pit), PSC 14 (the Battery Shop area), PSC 15 (the Solvent and Paint Sludge Disposal Area), PSC 48 (the Station’s Dry Cleaners - Building 106), and Building 780. In addition to the PSCs and Building 780, there are also seven isolated areas of elevated groundwater contamination identified as Areas A through G (Figure 2-3) within OU 3. PSC 16 (the Black Point Storm Sewer Discharge), which is located at the southern end of OU 3 (Figure 2-3), has also been investigated and assessed during the OU 3 Remedial Investigation and Feasibility Study (RI/FS) and is included in this ROD. PSC 16 was not originally designated as part of OU 3 (ABB-ES, 1995a).

The Navy is designated as the lead agency in the development of the selected remedies and in the preparation of this ROD. The Navy, USEPA and Florida Department of Environmental Protection (FDEP) are working together under a Federal Facilities Agreement, which created the framework for decision making on environmental cleanup at NAS Jacksonville. These three agencies, together with the Navy’s consultants, form the NAS Jacksonville Partnering Team. The Partnering Team, formed in 1993, guides the implementation of the Naval Installation Restoration Program.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES. The 134-acre OU 3 area consists mainly of the activities associated with the Naval Aviation Depot (NADEP), which is the largest tenant command at NAS Jacksonville. NADEP has been the major industrial complex at the facility since its inception in 1940 when NADEP’s predecessors first operated as a seaplane assembly and repair department. NADEP’s primary mission has been to perform in-depth rework, repair, and modification of aircraft engines, and aeronautical components. In addition to aircraft-related operation, NADEP also provides maintenance for various ground operating equipment (e.g., forklifts). Other than NADEP, OU 3 contains the helicopter flightline and the associated hangar areas plus the Station’s dry cleaning facility and various other industrial, shop, and office buildings.

The physical setting of the OU has undergone numerous changes over time. Old buildings have been demolished and new buildings constructed; in fact, this is an ongoing sequence of events at OU 3. Because of the aircraft and industrial activities, over 90 percent of OU 3 is covered with buildings or thick (greater than 1 foot in thickness) concrete pavement. During the early to mid 1940s, in order to meet the growing needs for repair of aircraft, hydraulic fill was used to expand the land area of NADEP along the St. Johns River.

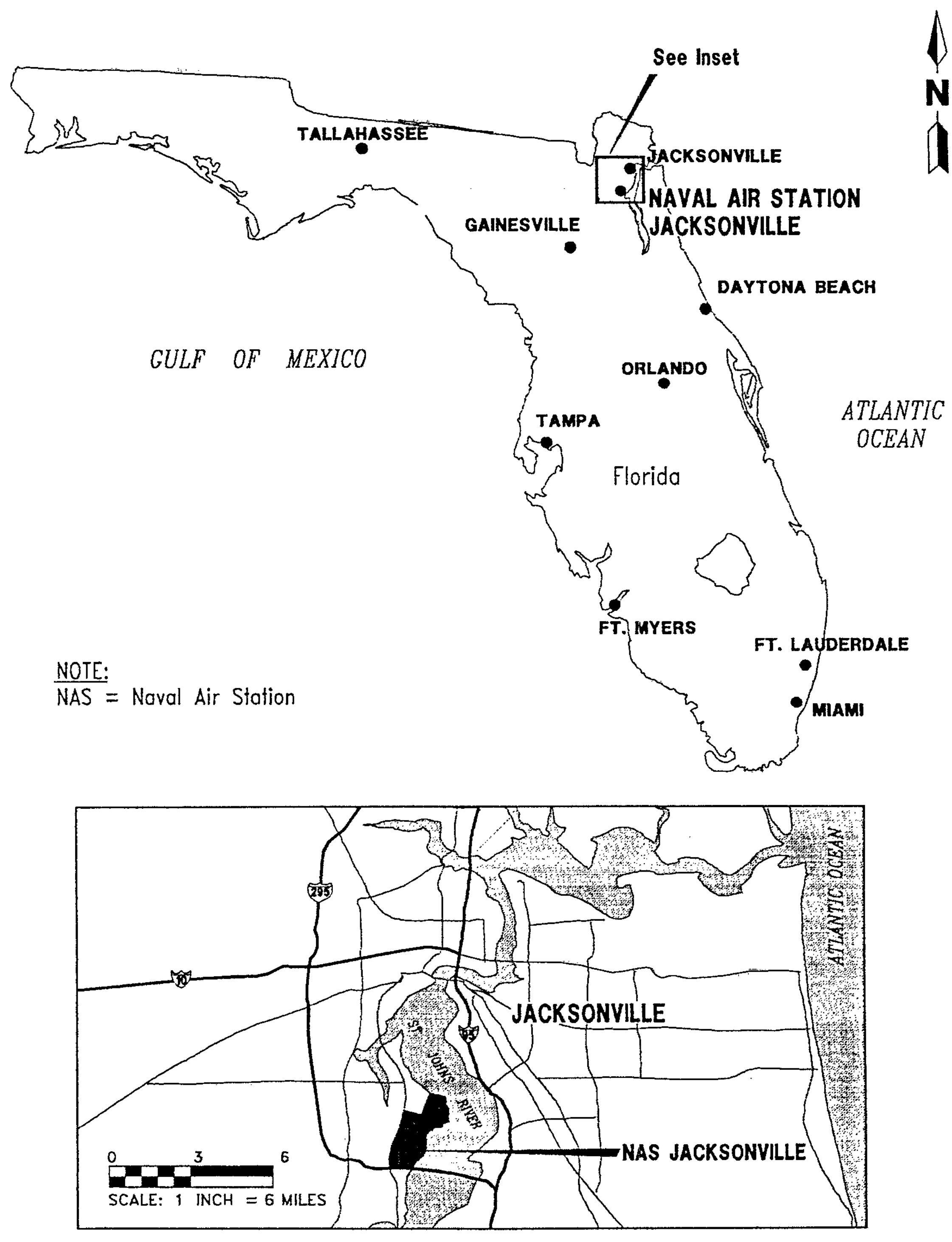

FIGURE 2-1
FACILITY LOCATION MAP

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RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

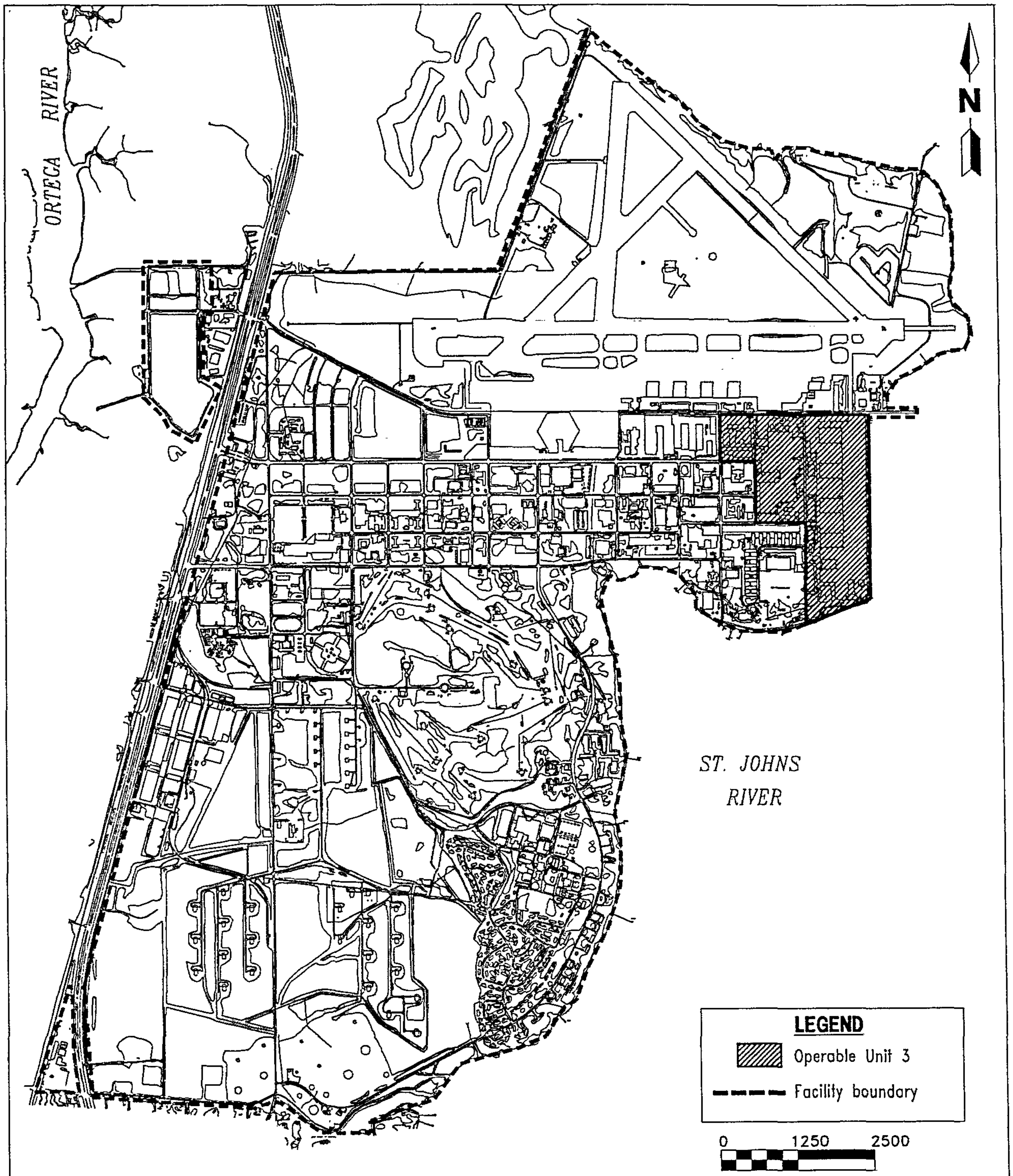

FIGURE 2-2
LOCATION OF OPERABLE UNIT 3

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RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

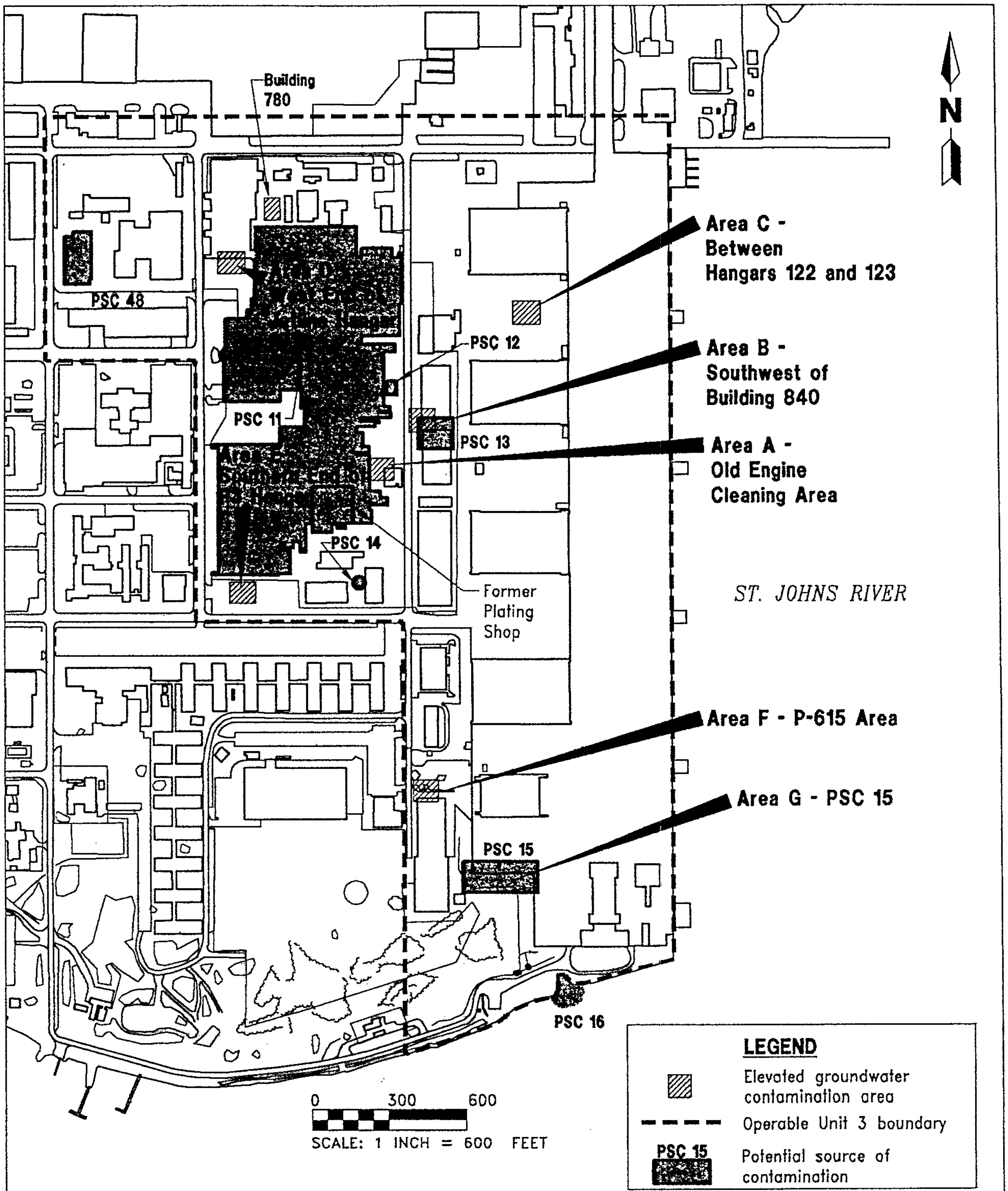

FIGURE 2-3

LOCATION OF PSCs AND AREAS OF ELEVATED GROUNDWATER CONTAMINATION

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RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

As part of the industrial activities at OU 3, there have been reports of numerous spills and disposal of hazardous substances onto or into the ground at the OU. To identify and assess the impacts from the hazardous material releases, several investigations and removal actions have been undertaken at OU 3 since 1982. Table 2-1 presents a summary of these past investigations and removal activities.

2.3 HIGHLIGHTS OF COMMUNITY PARTICIPATION. The RI/FS report and the Proposed Plan for OU 3 (Harding Lawson Associates [HLA], 2000a; 2000b) were completed and released to the public in April 2000. These documents, and other Installation Restoration program information, are available for the public's review in the Administrative Record and the Information Repository. The Administrative Record for OU 3 is located at Southern Division Naval Facilities Engineering Command in North Charleston, South Carolina, and the Information Repository is maintained at the Charles D. Webb Wesconnett Branch of the Jacksonville Public Library in Jacksonville, Florida. The notice of availability of these documents was published in The Florida Times Union April 26, April 30, and May 14, 2000.

A public comment period was held from April 17, 2000 to May 31, 2000. In addition, public meetings were held on May 2, 2000 and May 16, 2000, to present the Proposed Plan to a broader community audience than those that had already been involved at the site. At this meeting, representatives from the Navy, FDEP and USEPA answered questions about problems at the site and the remedial alternatives. The responses to the comments received during this period are included in the Responsiveness Summary, which is Chapter 3.0 of this ROD.

In addition to the public meeting, the Navy has actively participated in Restoration Advisory Board (RAB) meetings and has presented the issues, findings, and conclusions of the OU 3 RI/FS to the RAB members on several occasions. The NAS Jacksonville RAB is composed of community and government agency representatives who meet regularly to discuss the environmental program at NAS Jacksonville. At these meetings, community RAB members provide input and offer suggestions on environmental activities. The Navy has already incorporated feedback it solicited from the RAB into the RI/FS for OU 3.

2.4 SCOPE AND ROLE OF THE REMEDIAL ACTIONS. As with many National Priorities List sites, the problems at NAS Jacksonville are complex. There are 51 PSCs, some of which have been grouped into OUs.

Three OUs have been designated within NAS Jacksonville:

- OU 1: Former solid waste disposal and transformer storage areas (includes PSCs 26 and 27)

- OU 2: Former domestic and industrial wastewater treatment areas and fire fighting training area (includes PSCs 2, 3, 4, 41, 42, and 43)

- OU 3: NADEP industrial complex and associated helicopter flight line area (includes PSCs 11, 12, 13, 14, 15, and 48, see Figure 2-3).

OU remedial activities are phased based on program priorities, schedule effectiveness, task management, and funding capacity. Due to the large number of PSCs, the number of PSCs in each OU, the aggregate complexity of the

Table 2-1
Operable Unit 3 Investigative History

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Year	Document Name	Activities		Findings	
		Objective	Number of Study Component Samples	Contaminant Present	Conclusions
1982	Hazardous Waste Management Plan (Water and Air Research, 1982)	Compile inventory of generation, storage, and disposal of hazardous waste at NAS Jacksonville.	No samples were collected.	--	The Management Plan recommended OU 3 PSCs for Confirmation Study.
1983	Initial Assessment Study (Fred C. Hart Associates, 1983)	Evaluated the potential risk to human health and environment.	No samples were collected.	--	The IAS recommended PSCs 11, 12, 14, and 15 for Verification Study (NACIP Phase II).
1985	Results of sediment sampling at Plating and Cleaning Shop Building 101 (G&M, 1985a)	Assessed potential soil contamination beneath Building 101.	Five soil samples were collected.	Cyanide was detected in the soil samples.	No potential risk to human health was posed by area soil.
1985	Verification Study and assessment of potential groundwater pollutants (G&M, 1985b)	Verify absence or presence of contaminants at OU 3.	A total of 8 monitoring wells were installed and sampled at PSCs 11, 12, 13, 14, and 15.	Gross alpha and radium-226 were measured in groundwater at PSC 13. VOCs and cyanide were detected in groundwater at PSCs 11, 12, 14, and 15. TOC measurements were taken for groundwater samples at PSCs 11, 12, 14, and 15.	PSC 13 was recommended for No Further Action. PSCs 11, 12, 14, and 15 were recommended for Characterization Study. PSCs 11 and 15 were suspected sources of VOCs in groundwater.
1986	Characterization phase assessment of groundwater contamination (G&M, 1986)	Define magnitude of groundwater contamination.	Eighteen groundwater samples were collected.	VOCs were detected in several samples.	It was recommended that a monitoring well resampling program be conducted for risk assessment.
1988	Utility technical study, evaluation of stormwater drainage system cross connections in NADEP area (Robert Bates and Associates, 1988)	Identify potential sources of industrial and wastewater leaks.	No samples were collected.	--	Leaks were identified in OU 3 sewer and industrial lines.

See notes at end of table.

Table 2-1 (Continued)
Operable Unit 3 Investigative History

Year	Document Name	Activities		Findings	
		Objective	Number of Study Component Samples	Contaminant Present	Conclusions
1988	Findings from the subsurface investigation at Wright Street (G&M, 1988)	Assess potential soil and groundwater contamination.	24 soil samples and 14 groundwater samples were collected.	VOCs, metals, gross alpha, and gross beta were detected in groundwater samples.	It was recommended thatLevel C PPE be worn by persons excavating at site.
1989	Contamination assessment of Building 795 (G&M, 1989)	Determine potential health and safety risks at site.	6 soil samples and 2 groundwater samples were collected.	Metals, dieldrin, and 4,4-DDT were detected in the soil samples. Zinc was detected in the groundwater samples.	No constraints beyond standard safety practices were recommended.
1990	Technical Memorandum No. 1, Building 780 Area: Subsoil and Groundwater (G&M, 1990)	Develop soil and groundwater handling plans and develop health and safety standards.	5 soil samples and 2 groundwater samples were collected.	Chromium, lead, zinc, and 5 VOCs were detected in soil. Cadmium, nickel, zinc, and 11 VOCs were detected in groundwater.	Further analysis is required.
1992	Sampling Event Report No. 6, MILCON P615 (ABB-ES, 1992a)	Assess soil and groundwater contamination and potential health threat at proposed construction site.	12 soil samples and 6 groundwater samples were collected.	The pesticides endrin ketone and chlordane were detected in the soil samples. TCE was detected in the groundwater samples.	No health threat exists for construction workers as a result of soil and groundwater contamination.
1992	Health Threat Evaluation, (ABB-ES, 1992b)	Perform health threat evaluation for proposed construction at Building 780. Conduct air and tank sampling.	During three rounds of soil, groundwater, and air sampling over 40 samples were obtained.	1,1,1-trichloroethane and VC were detected in air samples.	Level C PPE suggested for workers in this area.
1992	Certification and Closure Report and CERCLA Soil Contamination Reduction, Building 101 (ABB-ES, 1995c)	Perform an emergency response removal action to demolish the building at a RCRA unit and excavate soil beneath the concrete as a CERCLA removal action.	Soil samples were collected to confirm adequate removal to satisfy cancer risk values. Quarterly groundwater monitoring is being conducted	Contaminants at Building 101 consisted primarily of metals resulting from the electroplating process used at the building. A total volume of 1,600 cubic yards of soil was removed and disposed.	RCRA closure requirements were satisfied for Building 101. Ongoing groundwater monitoring is being performed under the guidelines of RCRA.

See notes at end of table.

Table 2-1 (Continued)
Operable Unit 3 Investigative History

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Year	Document Name	Activities		Findings	
		Objective	Number of Study Component Samples	Contaminant Present	Conclusions
1993	Sampling Event Report No. 16, Building 101 USTs (ABB-ES, 1993b)	Assess potential contamination prior to UST abandonment and removal.	15 soil samples and 4 groundwater samples were collected.	VOCs and pesticides were detected in the groundwater samples.	Further characterization was recommended.
1993	Environmental Health Sampling at Albemarle and Wasp Street Utility Construction Site (ERS, 1993)	Assess potential ambient air, soil, and groundwater contamination at excavation site.	4 soil samples were collected.	VOCs were detected in the soil samples.	No special worker precautions were necessary.
1993	Sampling Event Report No. 15, P159 (ABB-ES, 1993a)	Assess potential health risks at proposed construction area.	12 soil samples and 7 groundwater samples were collected.	VOCs were detected in groundwater samples. Calculated cancer risks are well below the acceptable cancer risk of 1 x 10^{-6}.	Further characterization was recommended.
1993	Scoping Study Field Program (SSFP)) (ABB-ES, 1995a)	Conducted field screening of groundwater and soils to identify and characterize contamination at OU 3 in preparation for developing the RI program.	180 groundwater samples (from 63 locations) and 50 soil samples (from 15 locations) were collected.	Chlorinated volatile compounds (primarily PCE, TCE, TCA, methylene chloride and the various breakdown products) were detected in groundwater samples. Metals were the major contaminants identified in the soil samples. Semivolatile compounds derived from breakdown of fuel products were also detected in both soil and groundwater at generally much lower concentrations than for the VOCs.	Ten areas of groundwater contamination (high VOCs) were recommended for further investigation. No areas of significant soil contamination were identified during the SSFP.

See notes at end of table.

Table 2-1 (Continued)
Operable Unit 3 Investigative History

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Year	Document Name	Activities		Findings	
		Objective	Number of Study Component Samples	Contaminant Present	Conclusions
1995	EE/CA for Buildings 106 and 780 (ABB-ES, 1995b)	Determine if a non-time critical removal action was warranted to reduce present or future risk at these two locations.	A soil gas survey, groundwater pumping test, soil vapor extraction test, and air sparging test were performed at each location. In addition, groundwater samples were collected and biodegradation tests were conducted for each area.	Chlorinated VOCs, (PCE, TCE, DCE, and VC) were detected in groundwater at Building 106. TCA, DCA, TCE, DCE, and VC were identified in groundwater at Building 780.	Interim removal actions were recommended for Buildings 106 and 780. The IRAs consist of air sparging with soil vapor extraction at Building 106 and a pump-and-treat system with soil vapor extraction at Building 780.
1995	Radiological Survey of PSC 13 (BEI, 1995)	Conduct field screening and soil sampling at PSC 13 for radiological parameters.	A 100 percent area survey of the soil was conducted during the initial investigation; 40 soil samples were collected after removal of the contaminated soil.	Radiological contamination was present above regulatory standards. A total of 500 cubic yards of contaminated soil and other debris were removed and disposed at PSC 26. A survey performed after the soil removal indicated radiological contaminants did not exceed background.	U.S. Navy Radiological Affairs Support Office issued letter releasing PSC 13 for unrestricted use (RASO, 1995).
1996/ 1997	Engineering Evaluation of Areas With Elevated Groundwater Contamination at OU 3 (ABB-ES, 1998)	Evaluate the eight areas identified during the SSFP which have elevated groundwater contamination (hot spots) to determine the need for non-time critical removal actions.	77 groundwater samples and 4 soil samples were collected at OU 3. In addition, 6 groundwater samples were collected and analyzed for natural attenuation parameters.	Chlorinated VOCs (PCE, TCE, DCE, vinyl chloride, TCA, and methylene chloride) were detected at varying concentrations within the groundwater. No VOCs were identified in soils, only metals were detected.	IRAs were not warranted for the 8 hot spot areas. Evaluate groundwater treatment alternatives as part of the FS.
1997	Radiological Characterization Survey of PSC 15 (BEI, 1998)	Survey PSC 15 for potential radium-226 contamination resulting from disposal of luminous paint wastes from instrument repair and maintenance operations.	A gamma scan of 10 percent of the total site area was performed.	A total of 11 hot spots (gamma reading $ twice background) were identified, and 228 cubic yards of contaminated soil were removed and disposed at PSC 26. Due to stability concerns, contaminated soil around the concrete pad and pipes was not removed.	No Further Remedial Action Planned with land-use controls was recommended based on no unacceptable risk to human or ecological receptors.

See notes at end of table.

Table 2-1 (Continued)
Operable Unit 3 Investigative History

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Year	Document Name	Activities		Findings	
		Objective	Number of Study Component Samples	Contaminant Present	Conclusions
1997 to present	IRA for Building 106 (PSC 48) (ABB-ES, 1997; BEI, 1996; and HLA, 1996a)	Install an air sparging and soil vapor extraction system to reduce risks posed to human health and to the environment and to reduce contaminant concentrations in the groundwater and vadose zone soils at Building 106.	Quarterly groundwater monitoring at eight piezometers and 1 monitoring well continues at this time.	Construction of the remedial system began in 1997 and start-up of the system began in 1998. Groundwater monitoring has indicated that the system is effectively removing PCE, TCE, DCE, and VC from the contaminated media at Building 106.	Continue the ongoing operation of the remedial system at Building 106.
1997 to present	IRA for Building 780 (ABB-ES, 1997; BEI, 1996; and HLA, 1999b)	Install a groundwater extraction well and soil vapor extraction system to reduce risks posed to human health and to the environment and to reduce contaminant concentrations in the groundwater and vadose zone soils at Building 780.	Quarterly groundwater monitoring continues at this time.	Construction of the remedial system began in 1997 and start-up of the system began in 1999. Groundwater monitoring has indicated that the system is effectively removing contaminants (including VC, DCA, and DCE) from the contaminated media at Building 780.	Continue the ongoing operation of the remedial system at Building 780.
1998	Sampling Event Report for PSC 12 (HLA, 1998a)	Assess potential health risks from soil contamination at PSC 12.	2 soil samples were collected from the vadose zone.	No significant contamination was detected in the soils at PSC 12.	Recommended this site for No Further Remedial Action.
1998	Sampling Event Report for PSC 14 (HLA, 1998b)	Assess potential health risk from soil contamination at PSC 14.	1 soil sample was collected and analyzed for Target Analyte List inorganic compounds only.	13 inorganic parameters were detected however, only lead exceeded background levels for OU 3 (more than 3 times higher).	Even though lead exceeded OU 3 background levels and Florida standards for residential areas, it was below the Florida standards for industrial areas. Recommended this site for No Further Remedial Action with LUCs.

See notes at end of table.

Table 2-1 (Continued)
Operable Unit 3 Investigative History

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Year	Document Name	Activities		Findings	
		Objective	Number of Study Component Samples	Contaminant Present	Conclusions
1998	RI/FS for OU 3 (HLA, 2000a)	Characterize nature and extent of contamination at OU 3, identify the potential risks, and evaluate remedial alternatives.	4 groundwater, 8 soil, 13 surface water, 20 sediment and 21 storm sewer water samples were collected and analyzed during the RI field program.	The main contaminants of concern in groundwater and storm sewer water are chlorinated VOCs (primarily PCE, TCE, and the breakdown products). The only contaminants of concern for sediment were lead and PAHs. No contaminants of concern were identified for either surface water or soils.	The only media having unacceptable risks (requiring remediation) were groundwater and sediment. There were no unacceptable risk for storm sewer water, however, TCE did exceed Florida surface water standards.

Notes:
NAS = Naval Air Station.
OU = operable unit.
PSC = potential source of contamination.
NACIP = Naval Assessment and Control of Installation Pollutants.
VOCs = volatile organic compounds.
TOC = total organic carbon.
NADEP = Naval Aviation Depot.
BEI = Bechtel Environmental, Inc.
RASO = Radiological Affairs Support Office.
IRA = Interim Removal Action.
HLA = Harding Lawson Associates
PPE = personal protection equipment.
PCE = tetrachloroethene.
FS = Feasibility Study.
RI = Remedial Investigation.
TCA = trichloroethane.
EE/CA = Engineering Evaluation and Cost Analysis.
ABB-ES = ABB Environmental Services, Inc.
TCE = trichloroethene.
UST = underground storage tank.
DDT = dichlorodiphenyltrichloroethane.
ERS = Environmental Remediation Services.
DCE = dichloroethene.
IAS = Initial Assessment Study.
G&M = Geraghty and Miller.
MILCON = military construction project.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
RCRA = Resource Conservation and Recovery Act.
DCA = dichloroethane.
VC = vinyl chloride.
SSFP = Scoping Study Field Program.
PAHs = polycyclic aromatic hydrocarbons.
LUCs = land-use controls.

contamination problem at each OU, and funding limitations, the commencement of work at all OUs concurrently at NAS Jacksonville has not been feasible. Therefore, the Navy implemented a phased approach.

The assignment of priorities for the OUs was driven by the actual or potential threat posed by the aggregate known or suspected contamination. Based on hazard assessment, the Navy proceeded with the RI/FS for OU 1 first, the RI for OU 2 second, and the RI/FS for OU 3 third. The Navy, USEPA, and FDEP believe that this scheduled staggering provided for a coherent effort by the team enabling a higher quality assessment of the problems and more accurate identification of suitable remedial response actions.

Selected remedies have already been identified and implemented at OU 1 and OU 2. An Interim Record of Decision (IROD), signed in August 1994, addressed the light nonaqueous phase liquid (LNAPL) source at OU 1; and a ROD, signed in September 1997 addressed the LNAPL source, contaminated soils and sediments, contaminated groundwater, and a landfill cap. The remedial construction at OU 1 was completed in January 1999 and long term monitoring continues.

Two IRODs, signed in September 1994 and June 1995 respectively, addressed the contamination associated with the sludge drying beds and wastewater treatment polishing pond at OU 2. The IRAs were completed in September 1997 and as a result, a no further remedial action ROD was signed for OU 2 in October 1998. Resource Conservation and Recovery Act (RCRA) monitoring of groundwater conditions continues at OU 2.

The third OU, which is the subject of this ROD, addresses contamination in storm sewer water, groundwater, and sediment which may pose an unacceptable risk to human and ecological receptors. In addition, as part of the overall environmental remediation program instituted for OU 3, five IRAs have been completed or are ongoing:

- During the 1950s, radium paint waste, discarded luminous dials and associated contaminated soil were removed from the former disposal pit at PSC 13. Following a radiological survey of the area in 1995, additional contaminated soil and a few painted dials were found and removed from the area surrounding the former disposal pit. The contaminated soil and dials were placed beneath the landfill cap at OU 1 (Bechtel, 1995).

- During the period from 1992 through 1995, a removal action was conducted at the former plating shop located in the southeast corner of Building 101 (PSC 11). As part of the removal action, the tankage (storage, dip, and wash tanks) and all associated piping were removed along with the concrete floor and soil beneath the floor. Following tank and piping removals, the plating shop building was demolished and removed. RCRA groundwater monitoring continues at this location (ABB-ES, 1995c).

- In 1997, a radiological characterization survey in the PSC 15 area identified radium-226 contaminated soils. Remediation of the area by excavation was proposed. Contaminated soil, removed in 1998 and placed beneath the landfill cap at OU 1, was replaced with clean backfill. Due to stability concerns, small amounts of contaminated soil were left in place at depth beneath water pipes and a thick concrete pad (Bechtel, 1998).

- Two IRAs, designed to address contamination in the shallow groundwater aquifer, were started in 1998 and 1999. Air sparging with soil vapor extraction and carbon sorption is the selected treatment alternative at PSC 48, and groundwater extraction and treatment with soil vapor extraction and catalytic oxidation is being used at Building 780. These two IRAs are ongoing (HLA, 1999a and 1999b).

In addition to PSC 48 and Building 780, seven groundwater plumes (designated as Areas A through G) contaminated with chlorinated VOCs have been identified beneath OU 3. For two of these plumes, Areas A and E, it was determined that additional groundwater monitoring data and evaluation would be necessary before a final remedy could be selected. Therefore, groundwater remedies for Areas A and E are not included in this ROD, but will be addressed later (within 1 to 3 years) in a separate ROD. Likewise, there are currently three RI/FSs (PSC 21, PSC 51, and Hangar 1000) ongoing at NAS Jacksonville which will subsequently result in RODs. It is expected that these RODs will also be developed within the same 1 to 3 year time frame.

2.5 SITE CHARACTERISTICS. There are a number of physical features and conditions that significantly affect the transport of contaminants at OU 3. As stated earlier, over 90% of the area within OU 3 is either covered by buildings or a thick layer of pavement. In general, the only exposed soil is at the southern end of the OU near PSC 16 or in small, generally unvegetated, strips along a few of the buildings. As a result of all the buildings and pavement there are no surface waterbodies, wetlands, or drainage courses on OU 3. Storm water runoff is picked up in drainage inlets or catch basins and directed to the storm sewer system, which discharges to the St. Johns River.

OU 3 is underlain by interbedded layers of sand, clayey sand, sandy clay, and clay (Figures 2-4 through 2-7). Groundwater, and the migration of contaminants in groundwater, is controlled by a complex stratigraphy. In the northern half of OU 3, the surficial aquifer is divided into an upper and lower zone by an extensive low permeability clay layer (greater than 10 feet in thickness) which increases in thickness to separate the lower zone of groundwater in the northern portion of OU 3 from the lower zone of groundwater in the southern portion as shown in Figures 2-5 and 2-6. The upper zone of groundwater (referred to as the shallow portion of the surficial aquifer) extends from 5 feet to approximately 20 feet, and the lower zone extends from approximately 30 feet to 85 feet, below ground surface.

In the southern half of the OU the upper and lower zones of the surficial aquifer are not separated by a continuous clay layer, however, several discontinuous clay lenses exist. Groundwater flow at OU 3 has been modeled by the U.S. Geological Survey (USGS) with results for groundwater flow pathlines shown in Figures 2-8 and 2-9. Groundwater flow is generally from west to east, toward the St. Johns River. However, groundwater flow in the upper layer is strongly influenced by leakage into the storm sewer system and by the presence of the seawall along the St. Johns River.

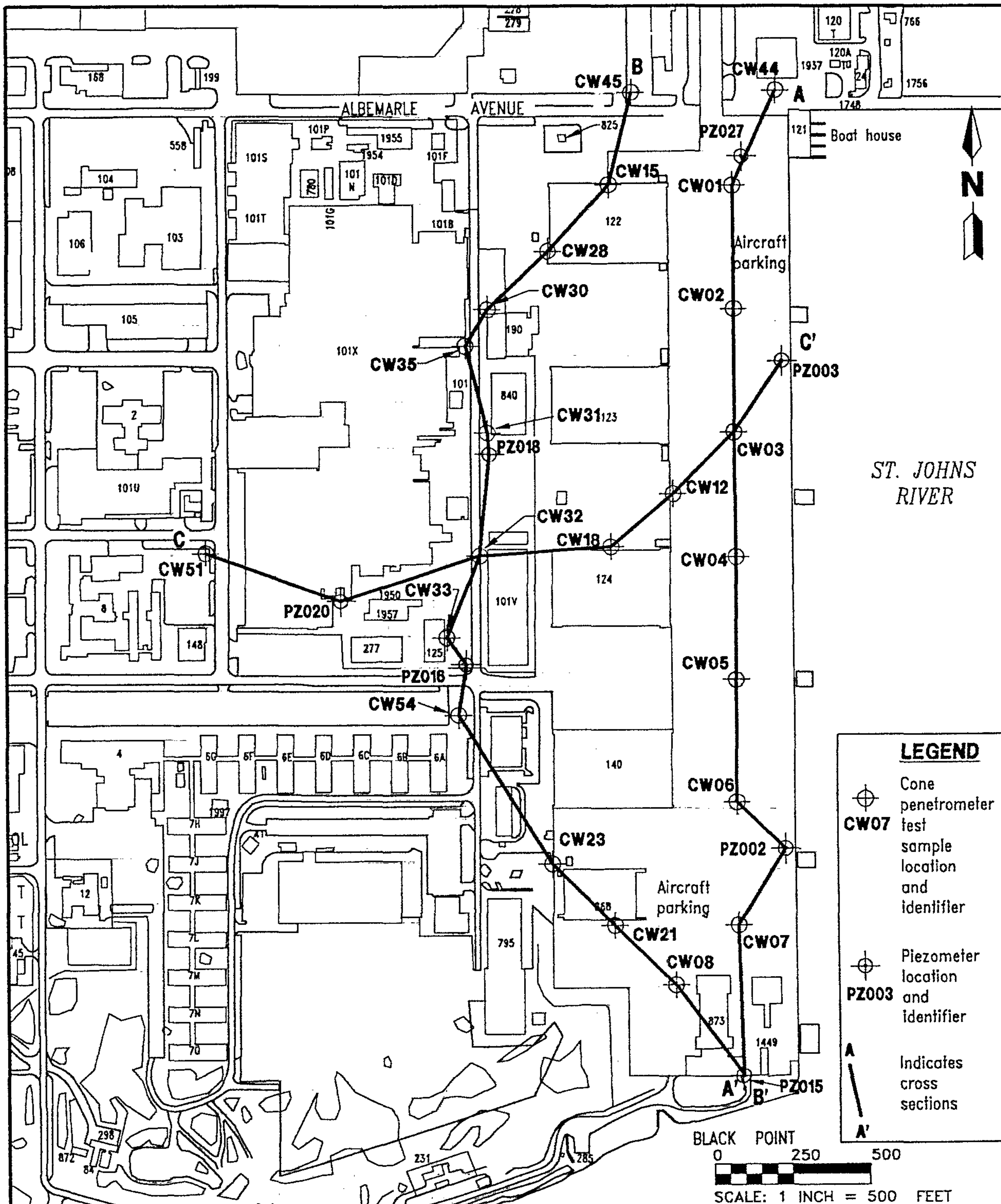

FIGURE 2-4
LOCATIONS OF GEOLOGIC CROSS-SECTION LINES

RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

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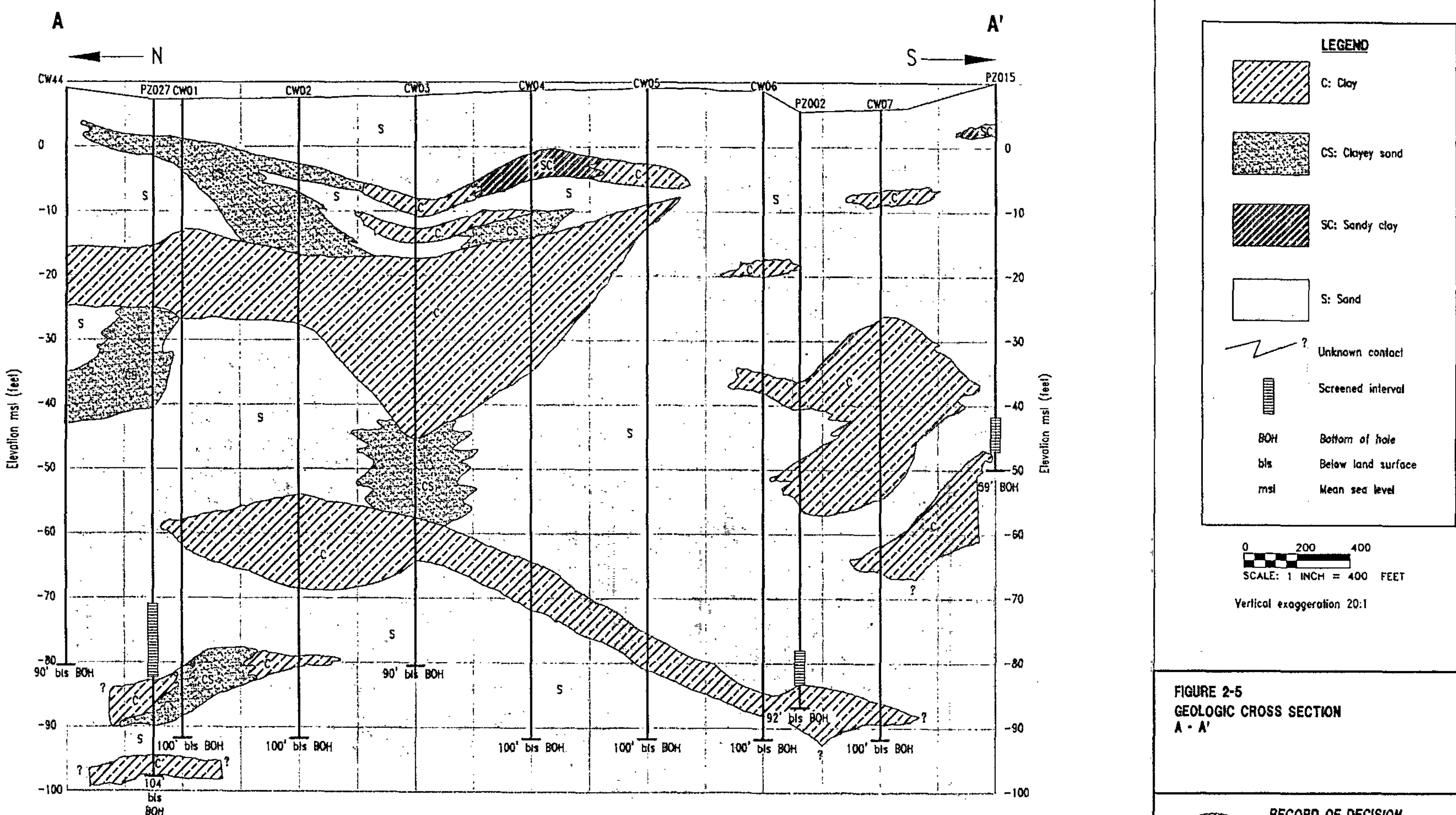
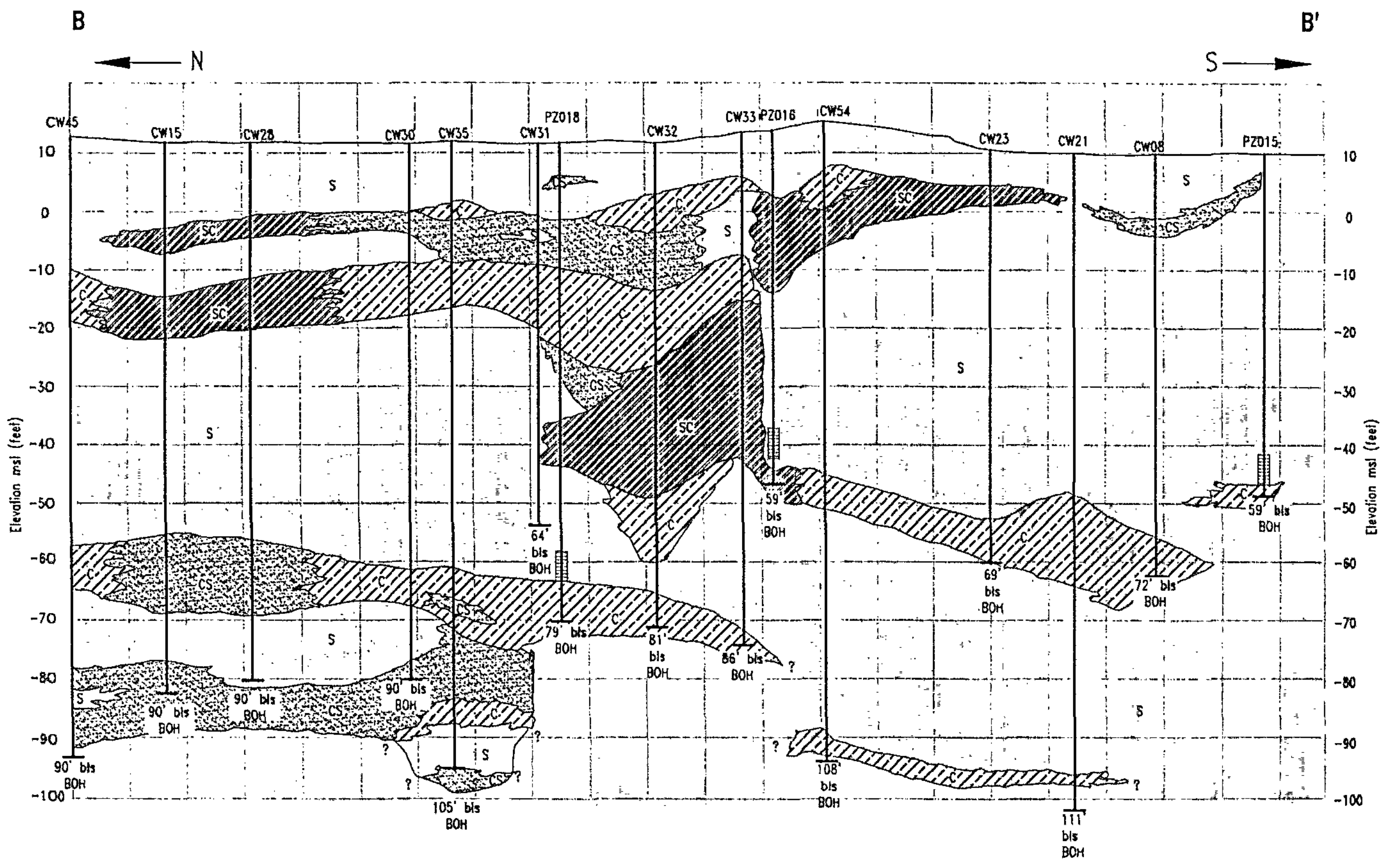


FIGURE 2-5
GEOLOGIC CROSS SECTION
A - A'

RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA



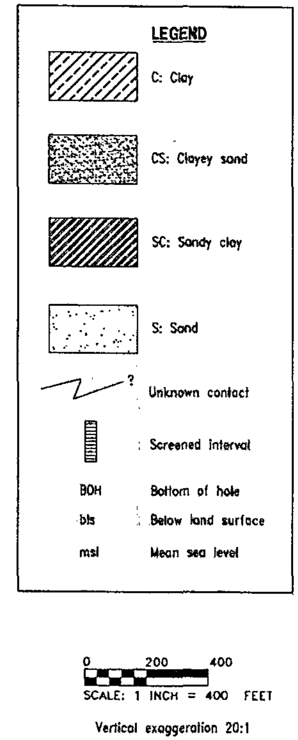


FIGURE 2-6
GEOLOGIC CROSS SECTION
B - B'

RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

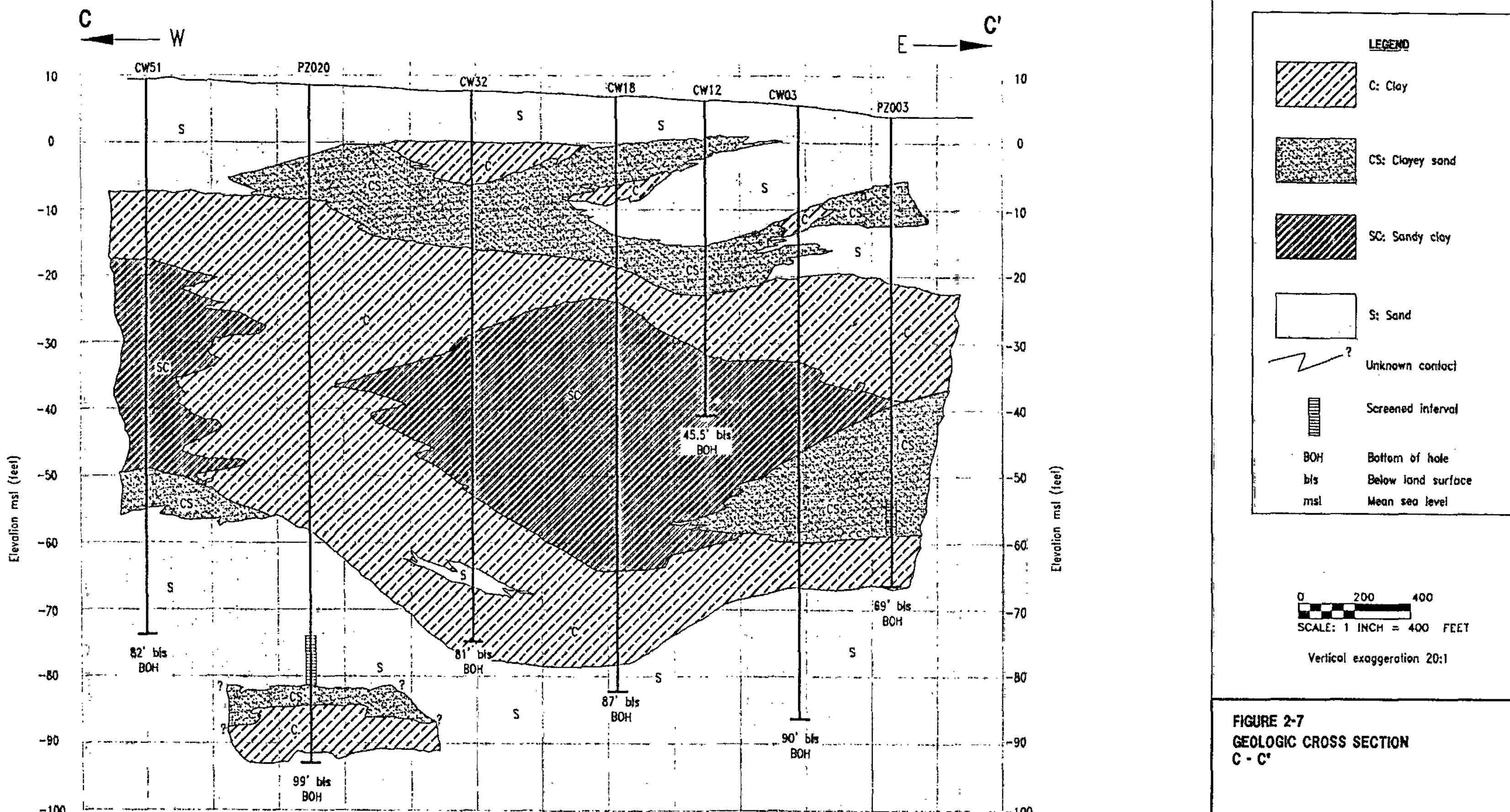
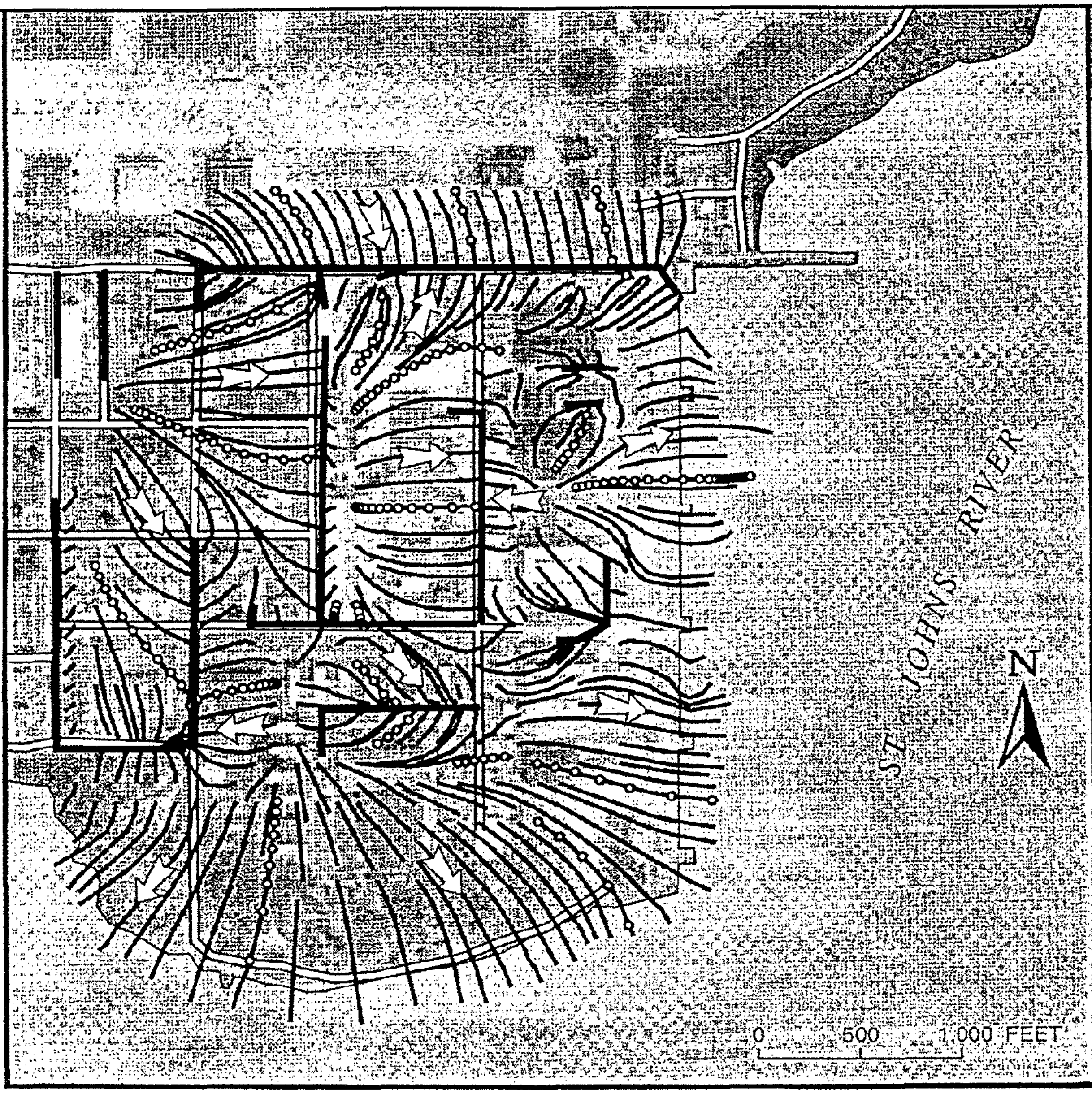


FIGURE 2-7
GEOLOGIC CROSS SECTION
C - C'

RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA



LEGEND

Particle pathline– shows simulated groundwater flowpath in the upper layer; distance between dots represents a travel time of 40 years

Groundwater flow arrow – shows direction of groundwater flow along pathlines

Storm water drain assumed to be leaking

Source: Davis,H.J., 1998

FIGURE 2-8
PARTICLE PATHLINES REPRESENTING GROUNDWATER FLOW DIRECTIONS IN UPPER LAYER OF SURFICIAL AQUIFER

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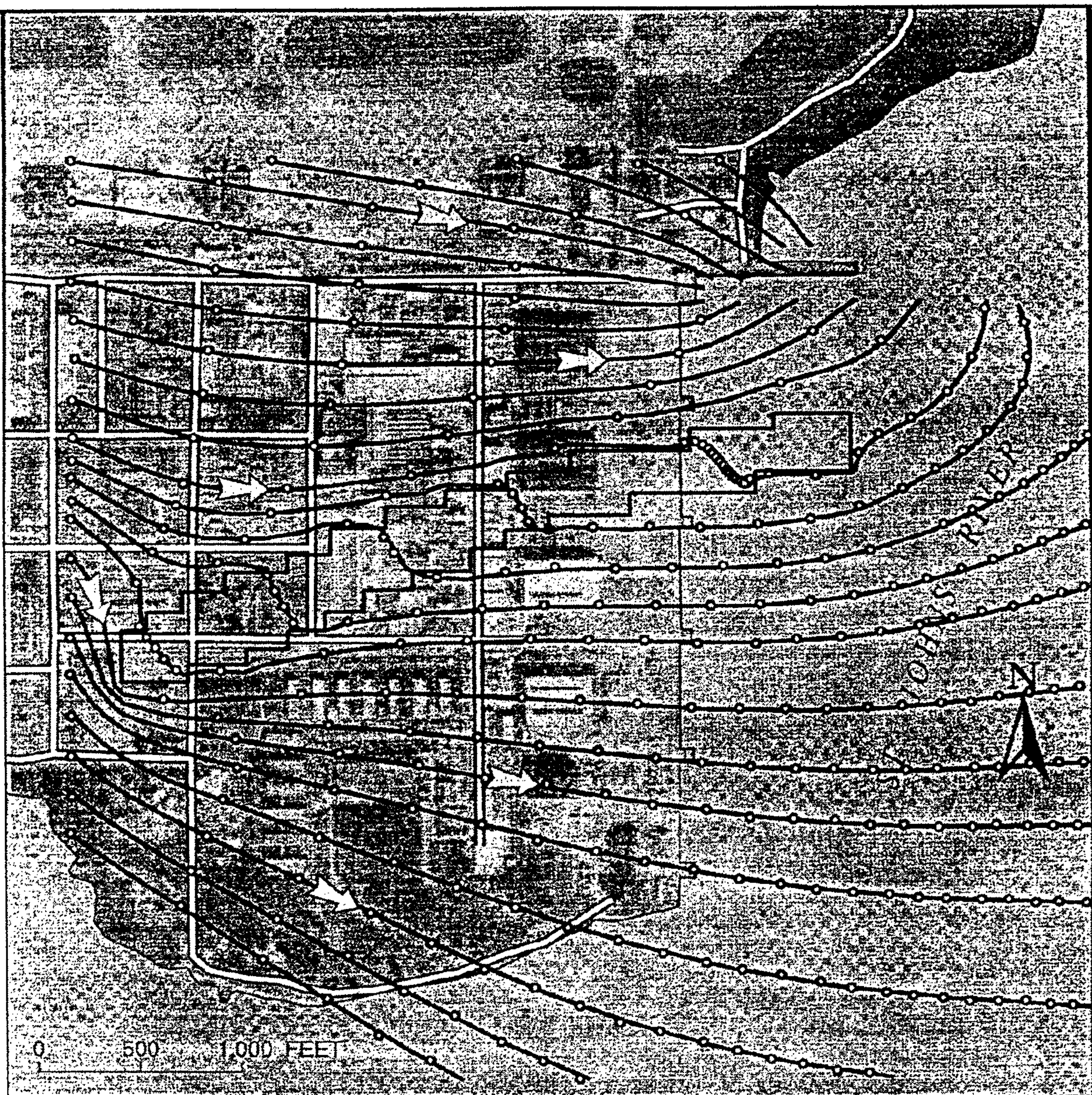
RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA



Source: Davis,H.J., 1998

LEGEND

Particle pathline– shows simulated groundwater flowpath in the intermediate layer; distance between dots represents a travel time of 20 years

Groundwater flow arrow – shows direction of groundwater flow along pathlines

Low–permeability channel–fill deposits

FIGURE 2-9
PARTICLE PATHLINES REPRESENTING GROUNDWATER FLOW DIRECTIONS IN INTERMEDIATE LAYER OF SURFICIAL AQUIFER

RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

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During the 1993 initial field investigations for the RI at OU 3, groundwater was investigated by using direct-push technology (DPT) methods. Groundwater samples were collected and analyzed from three different depths throughout OU 3. Figure 2-10 shows the location of these sampling points. In addition, nested monitoring wells were installed at 15 locations throughout OU 3. Figure 2-11 shows these well locations. Based on the analytical results from the DPT investigation, it was determined that there were nine areas which had elevated groundwater contamination, mainly with chlorinated volatile organic compounds (tetrachloroethene [PCE] and trichloroethene [TCE] and their breakdown products dichloroethene [DCE] and vinyl chloride [VC]). Subsequent field investigations used soil borings, monitoring wells, and DPT probes to further investigate and delineate these nine “hot spot” areas.

Even though low levels of VOCs are found ubiquitously in the groundwater at OU 3, contaminants (chlorinated solvents) are only found at unacceptable concentrations at the nine relatively small hot spots (six in the upper layer of the surficial aquifer and three in the lower layer [referred to as the intermediate zone]). Figure 2-12 shows the location of these hot spots, which are identified as PSC 48, Building 780, and Areas A through G. The plumes associated with these hot spots are small, isolated, discrete areas covering only 11 acres out of the 134 acres encompassing OU 3 (see Figure 2-12). Table 2-2 provides an estimate of the contaminant volume and the plume area for Areas A through G. It should be noted, as stated in Section 2.4, Areas A and E are NOT being considered in this ROD.

Groundwater concentrations at PSC 48 and Building 780 are high enough to suspect residual dense nonaqueous phase liquid within the groundwater aquifer, and these two areas are being subjected to IRAs (see Table 2-1). However, no other ongoing source of contamination has been identified at OU 3 either above or below the water table, and therefore the soils at OU 3 appear to be relatively free of contamination.

In addition to soils and groundwater, samples were collected and analyzed from the water in the storm sewers and from surface water and sediment in the St. Johns River. Based on evaluation of the analytical results, only groundwater and sediment were found to contain contaminants which caused an unacceptable risk for human or ecological receptors. Sediment samples collected from near PSC 16 contained polycyclic aromatic hydrocarbons (PAHs) at concentrations up to 18,000 micrograms per kilogram (Fg/kg) and lead as high as 185 milligrams per kilogram (mg/kg). Even though the storm sewer water did not cause a risk to humans or ecological receptors, the TCE levels (100 micrograms per liter [Fg/R]) in the water did exceed the Florida Surface Water Standards (Florida Legislature, 1996). Figure 2-13 shows the conceptual site model, which was used to identify and evaluate the exposure pathways for human and ecological receptors at OU 3. Because of the extensive presence of buildings and pavement and the lack of exposed soil, it was determined that there is little nesting or foraging area at OU 3; therefore, the major ecological receptor pathway is associated with the St. Johns River. Also, since there is currently no exposure or use of the groundwater by the workers at OU 3, groundwater contamination would only provide a risk to humans if it were used in the future as a source of drinking water. Even though this is unlikely, the drinking water scenario was considered as a possible future use for the groundwater. Other than the water used as a drinking source, the St. Johns River is the physical endpoint for contaminants that migrate through the groundwater and storm sewer system at OU 3.

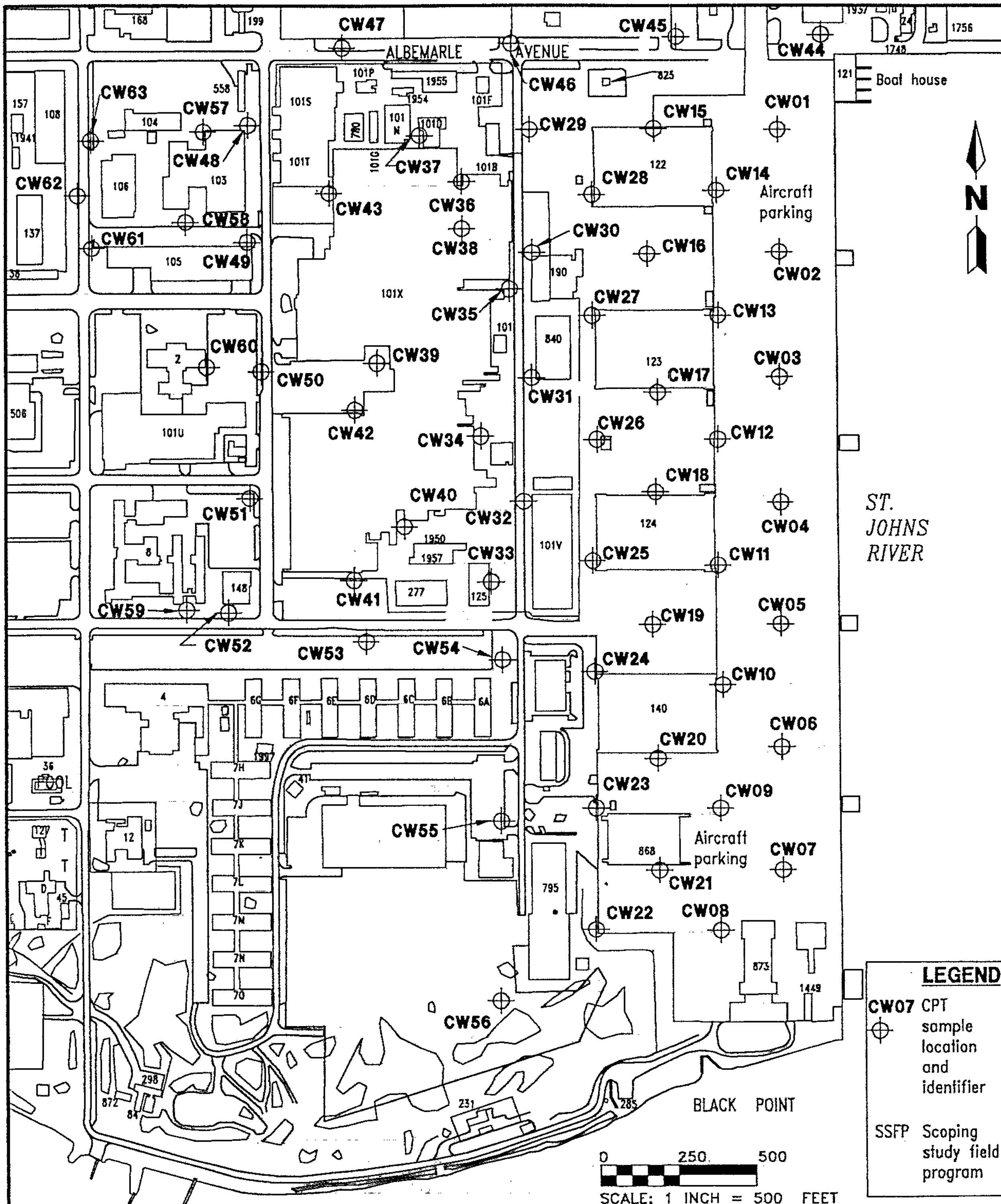

FIGURE 2-10
LOCATIONS OF CONE PENETROMETER TESTS (CPT) AND GROUNDWATER SAMPLING POINTS CONDUCTED DURING THE SSFP

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RECORD OF DECISION
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NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

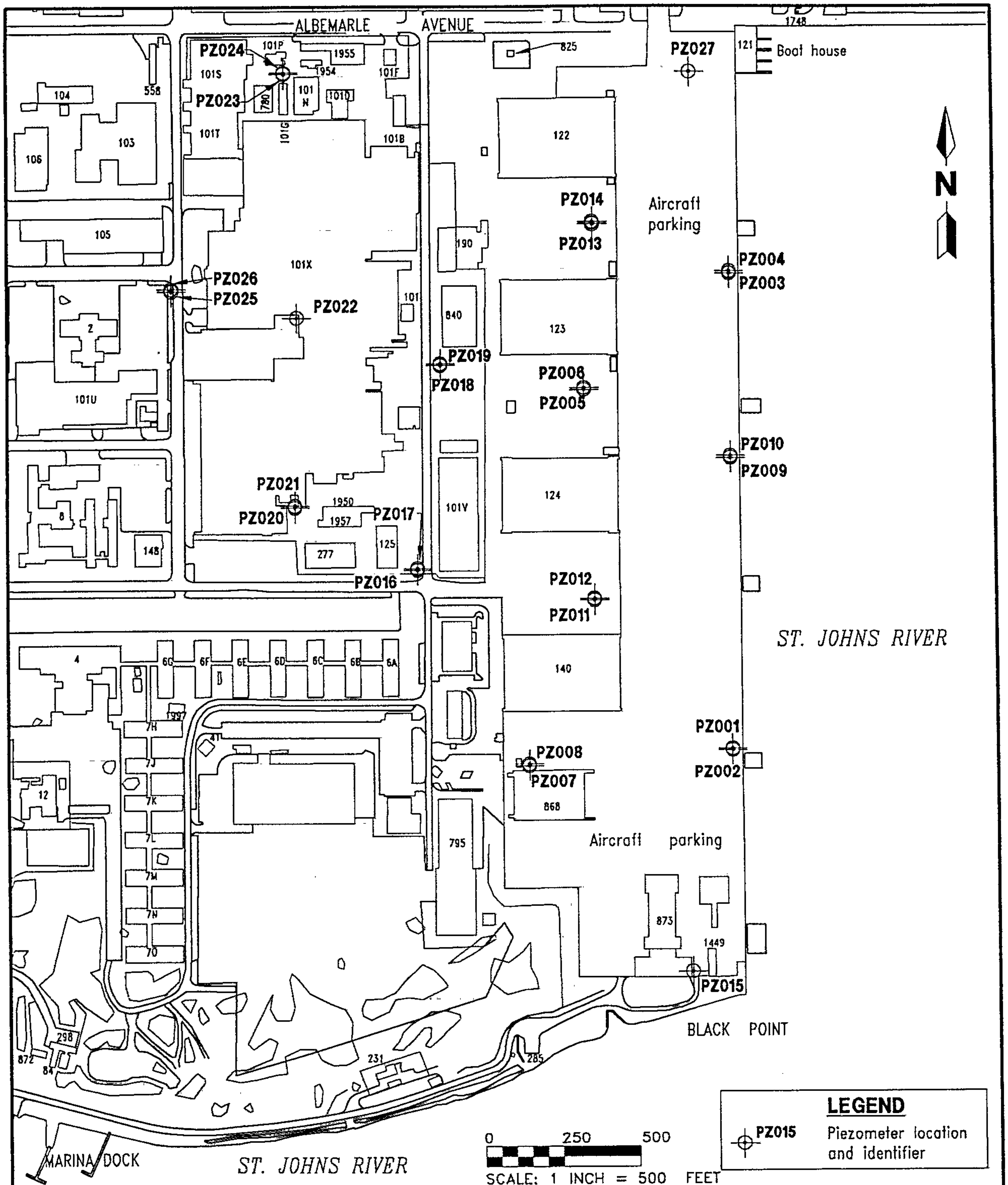

FIGURE 2-11
LOCATIONS OF NESTED MONITORING WELLS

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RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

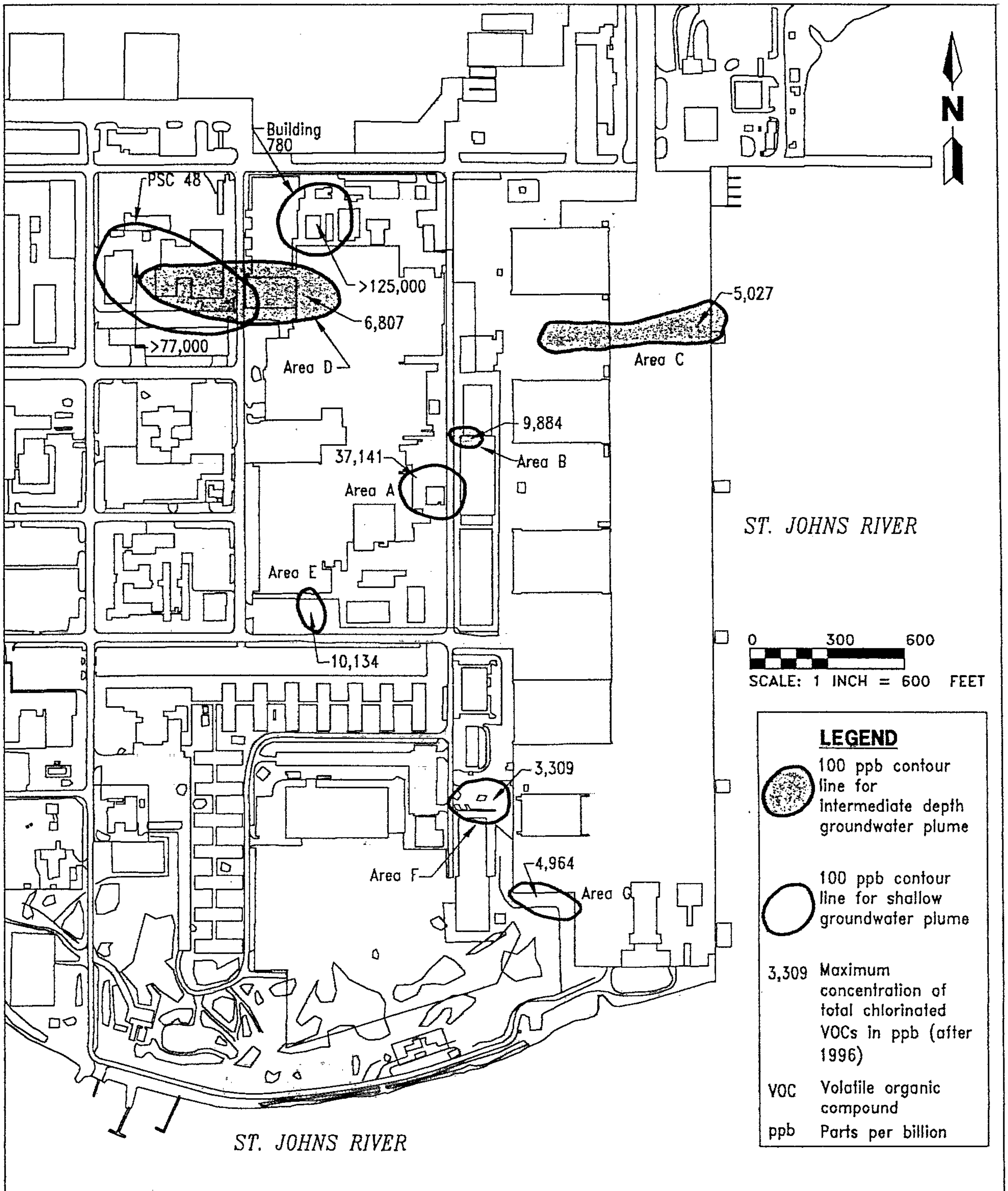

FIGURE 2-12

CHLORINATED VOC GROUNDWATER PLUMES

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RECORD OF DECISION OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE JACKSONVILLE, FLORIDA

Table 2-2
Estimated Dimensions of Elevated Groundwater Contamination Areas

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station, Jacksonville
Jacksonville, Florida

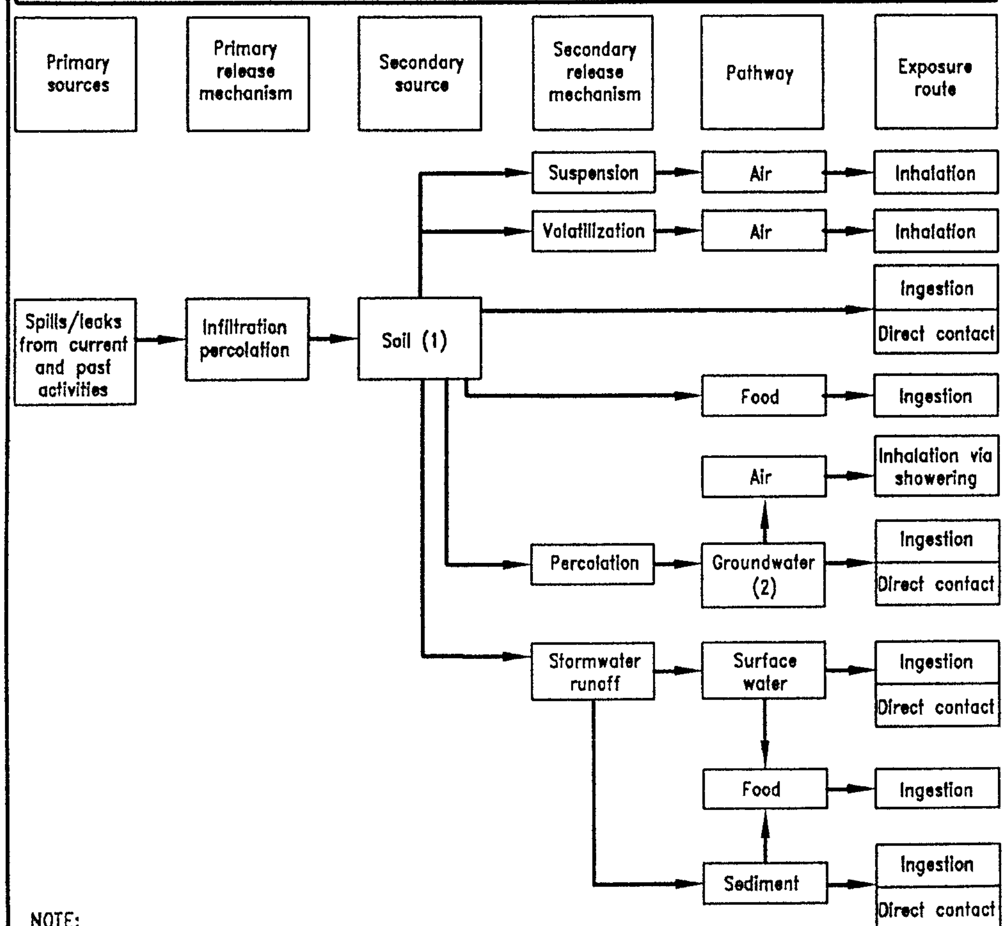
Area	Predominant VOC present	Estimated Total Area (ft^2)	Estimated Plume Thickness (feet)	Estimated Upper Boundary (ft bls)	Estimated Lower Boundary (ft bls)	Estimated Total Volume of Contaminated Groundwater (ft^3)	Estimated Total Contaminant Mass (kg)
Area A	TCE	48,250	11	7	18	132,700	32.8
Area B	TCE	10,150	10	35	45	23,375	1.7
Area C	TCE	29,400	10	30	40	71,000	3.5
Area D	TCE	134,050	25	27	52	837,125	51.0
Area E	PCE	11,950	10	6	16	29,875	4.7
Area F	TCE	28,900	10	15	25	72,250	4.0
Area G	TCE	23,900	10	10 to 30*	20 to 40*	59,750	3.9

Notes: Total contaminant mass calculations based on the mass of the predominant chlorinated solvent compound in the plume (TCE except Area E which is based on PCE).

All calculations, including assumptions used, can be found in the Remedial Investigation and Feasibility Study for Operable Unit 3, Naval Air Station Jacksonville Appendix C-8, (HLA, 2000a).

PSCs = potential sources of contamination.
VOC = volatile organic compound.
ft^2 = square foot.
ft bls = feet below land surface.
ft^3 = cubic feet.
kg = kilogram.
TCE = trichloroethene.
PCE = tetrachloroethene.
* = A range of depths is provided because the plume dips towards the east.

Potential Exposure Pathways



Receptors

Pathway / Exposure route	Human: Trespasser/ recreational user	Human: Future occupational worker	Human: Excavation/ utility worker	Biota: Terrestrial	Biota: Aquatic
Air (suspension) – Inhalation			●		
Air (volatilization) – Inhalation			●	●	
Soil – Ingestion			●	●	
Soil – Direct contact			●	●	
Food – Ingestion				●	
Air – Inhalation via showering					
Groundwater (2) – Ingestion		●			
Groundwater (2) – Direct contact					●
Surface water – Ingestion	●			●	●
Surface water – Direct contact	●			●	●
Food – Ingestion				●	●
Sediment – Ingestion				●	●
Sediment – Direct contact				●	●

NOTE:
(1) Soil is considered subsurface because it is below pavement; therefore, only excavation workers are considered viable receptors.
(2) Potable water sources are available currently. Future occupational worker ingestion is considered as a potential worst–case scenario.

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FIGURE 2-13
CONCEPTUAL SITE MODEL
FOR HUMAN AND ECOLOGICAL RECEPTORS

RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

The USGS used the numerical model MT3D (Zheng, 1990) to provide predictions of contaminant transport through the groundwater. Even though plumes exist within the groundwater system they are migrating very slowly. The numerical model shows that it will take 60 years or longer for the contaminated plumes (e.g., Area C) to reach the St. Johns River (see Figures 2-14, 2-15 and 2-16). Because of the clay aquitard that separates the upper and lower portions of the surficial aquifer, as can be seen in the figures, groundwater flow and the contaminant plumes from Areas B, C, and D migrate considerable distances beneath the river before moving vertically upward into the upper layer and ultimately into the river. In the southern portion of OU 3, where the clay aquitard is not continuous, the groundwater plumes (Areas F and G) are moving so slowly that the numerical model determined that the contaminants would be attenuated to nondetectable levels before reaching the river.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES.

<u>Land Use</u>: Current land use at OU 3 is primarily for activities conducted by NADEP. NADEP’s mission is to maintain and operate facilities with which to perform a complete range of rework operations on aircraft, including their engines and all components and accessories; provide engineering services in the development of changes in hardware design; and furnish technical services on aircraft maintenance and logistic problems. OU 3 also consists of runways, hangars, roads, buildings, and largely paved areas between the buildings. There is very little unpaved surface area. Being a heavy industrial area, access to OU 3 is restricted by fence and security guards and is limited to NADEP personnel and authorized visitors.

NADEP is bordered on the east and south by the St. Johns River, on the west by various NAS Jacksonville operations such as offices and a machine shop, and the on north by the flightline. The St. Johns River shoreline at OU 3 is mostly paved (pavement ends at the seawall) except on the southern shore where it is rocky.

The station is not scheduled to be closed in the foreseeable future, so the land use will remain industrial. If the station were to close in the future, it is improbable that the land use would be changed from an industrial land use to a residential land use because the area is so heavily industrialized. Additionally, the airstrip bordering OU 3 to the north would make the land more attractive as an airport. Also, the thickness of the concrete (18 inches) over most of the soil would have to be removed before residential development, probably making the project cost prohibitive. Lastly, the first 100 feet of land next to the St. Johns River would be subject to shoreland zoning which would further restrict the type of activity or development that could occur.

<u>Groundwater Use</u>: Groundwater from the surficial aquifer is not currently used at NADEP. Although it is unlikely and infeasible (due to low aquifer yield) that drinking water wells would be installed at OU 3 in the surficial aquifer, the NAS Jacksonville Partnering Team agreed to take a conservative approach and consider potential beneficial use as drinking water.

<u>Surface Water Use</u>: There is no surface water located within the boundaries of OU 3; however, the OU does abut the St. Johns River on the east and south. Currently, the St. Johns River is used for commercial and recreational purposes

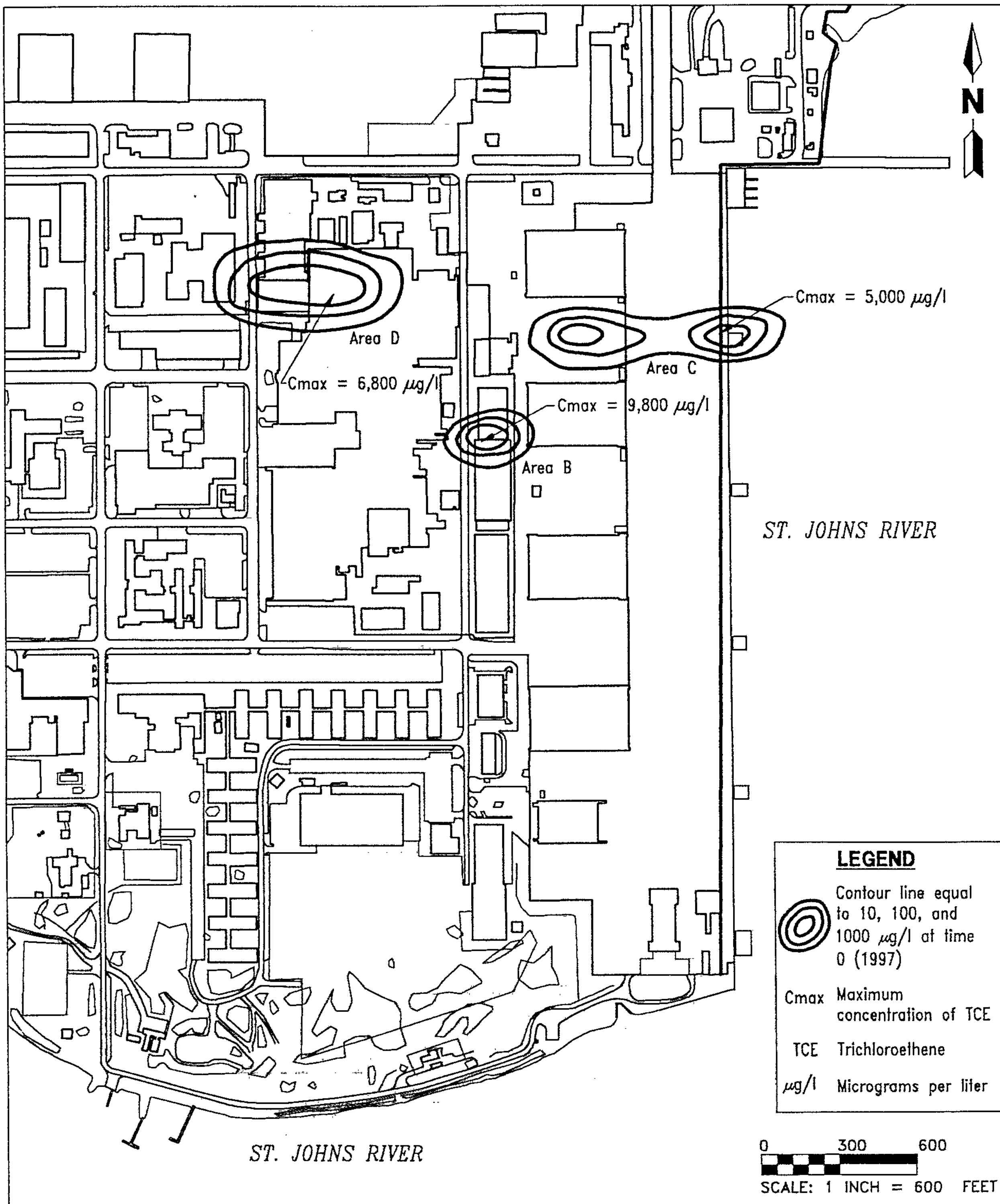

FIGURE 2-14
MT3D MODEL, CURRENT CONDITIONS - TCE CONTAMINANT PLUMES IN INTERMEDIATE LAYER BELOW THE CLAY AQUITARD

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RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

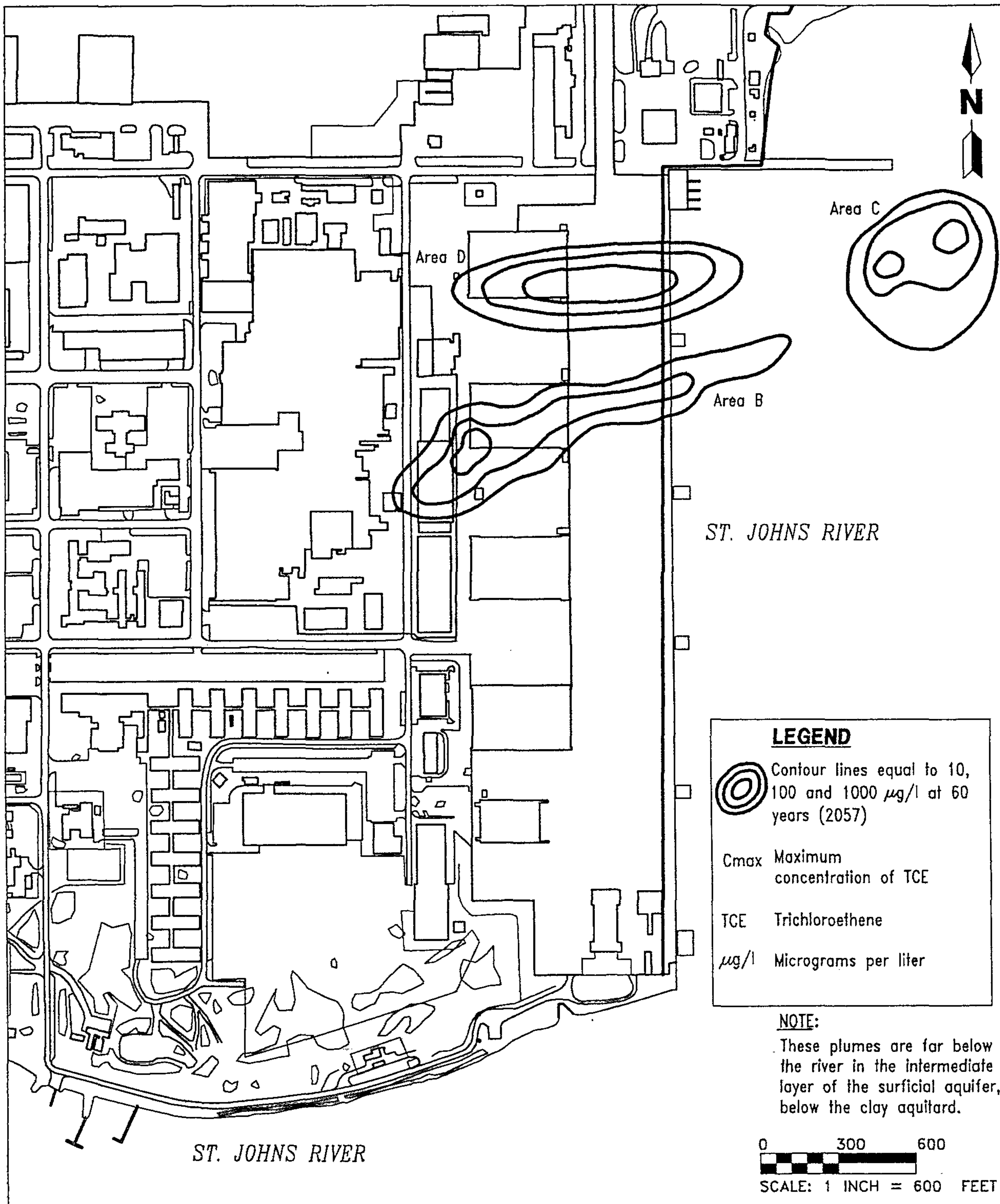

FIGURE 2-15
MT3D MODEL, FUTURE CONDITIONS - TCE CONTAMINANT PLUMES IN INTERMEDIATE LAYER BELOW THE CLAY AQUITARD

K:\02562\02562-11\ROD\02562604.DWG, BB-VC 05/24/00 10:20:35, ACAD14

RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

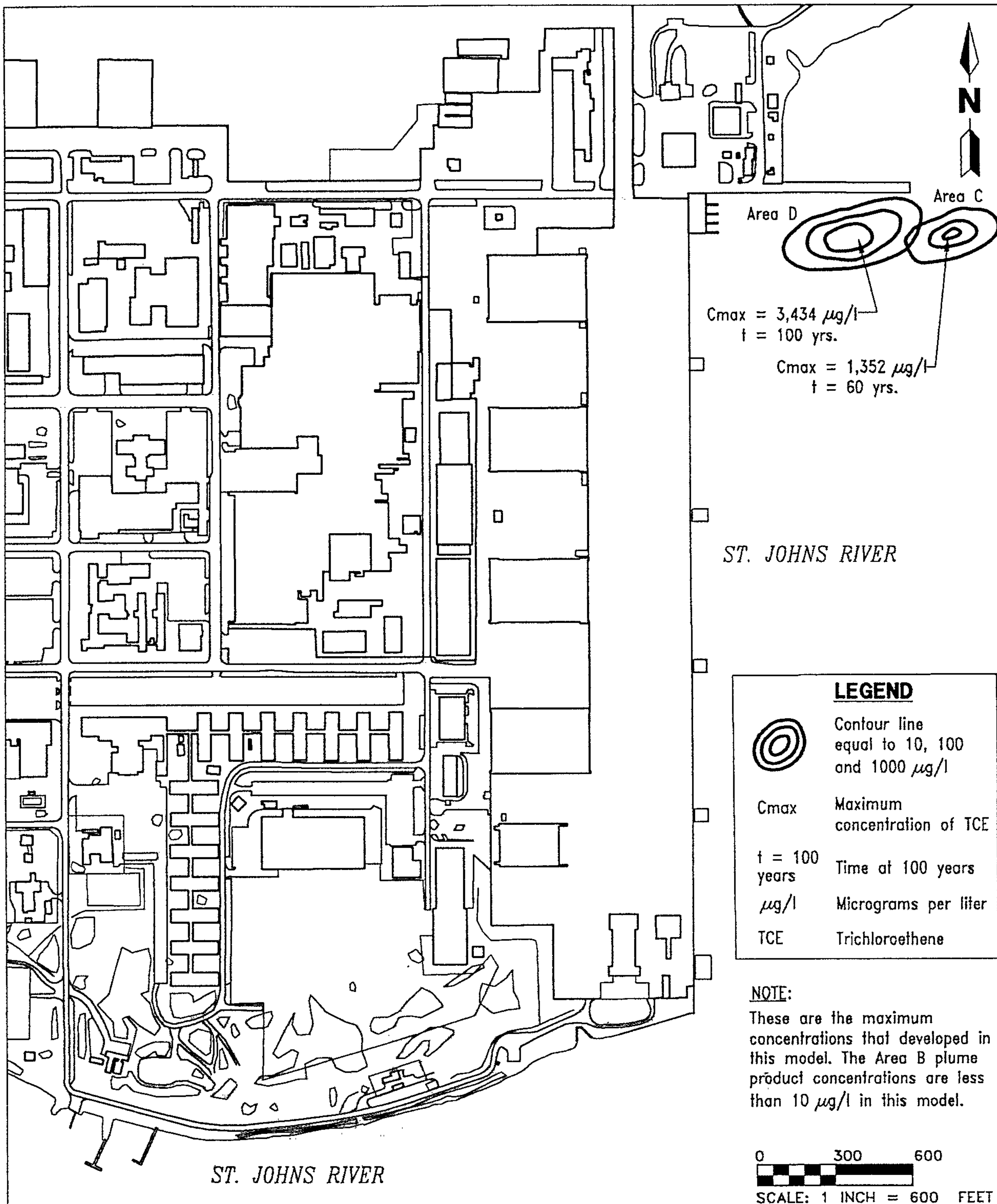

FIGURE 2-16
MT3D MODEL, FUTURE CONDITIONS - TCE CONTAMINANT PLUMES IN UPPER LAYER ABOVE THE CLAY AQUITARD, BELOW RIVER BED

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RECORD OF DECISION
OPERABLE UNIT 3

NAVAL AIR STATION JACKSONVILLE
JACKSONVILLE, FLORIDA

by adults and adolescents. It is anticipated that the St. Johns River will always be used for commercial and recreational purposes.

<u>2.7 SUMMARY OF SITE RISKS</u>. This section of the ROD states the basis for taking action at OU 3, provides a brief summary of the relevant portions of the human health risk assessment, and provides a brief summary of the ecological risk assessment. Only those exposure pathways and scenarios “driving” remedial action are summarized here.

<u>2.7.1 Summary of the Human Health Risk Assessment</u> The human health baseline risk assessment estimates what risks the site poses to human health if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the human health baseline risk assessment for this site.

<u>Identification of Chemicals of Concern</u> - Using USEPA’s criteria (USEPA, 1995), contaminants of concern (COCs) regarding risk to human health have been selected. Groundwater COCs depend on the Area under consideration and are listed in Tables 2-3 through 2-7 for Areas B, C, D, F, and G, respectively.

Only Area D has a COC other than VOCs, and it is arsenic, with a probable exposure concentration of 17 Fg/R. The primary VOC in groundwater is TCE and it ranges from a probable exposure concentration of 1,700 Fg/R at Area C to 9,800 Fg/R at Area B. For comparative purposes, the USEPA drinking water standard for TCE is 5 Fg/R (USEPA, 1996).

Storm sewer water COCs are listed in Table 2-8, where the range and frequency of detection and the exposure point concentrations (EPCs) for these COCs are also presented. The risk assessment determined that there was no unacceptable risk for the utility worker scenarios examined, however, the storm sewer water concentrations of TCE (up to 170 Fg/R) exceed the State of Florida surface water standard (80.7 Fg/R) and therefore the contamination in the storm sewer is unacceptable (Florida Legislature, 1996).

<u>Exposure Assessment</u>. The exposure assessment for OU 3 involves the identification of potential exposure pathways for human receptors. Potential receptors exposed to contamination associated with OU 3 have been identified by considering present and future land, groundwater, surface water, and storm sewer uses. The current land use for OU 3 is heavy industrial. The station is not scheduled to be closed in the foreseeable future, so the land use will remain industrial. If the station were to close in the future it is improbable that the land use would be changed from an industrial land use to a residential land use because the area is so heavily industrialized. Therefore, as agreed by the USEPA, FDEP, and the Navy, the future residential land use scenario has not been considered in the human health risk assessment. Access to OU 3 is restricted by fence and security guards and is limited to NADEP personnel and authorized visitors. Therefore, a trespasser scenario was also not considered.

The station obtains its drinking water supply from the Public Works Center, NAS Jacksonville (potable wells screened in the Floridan aquifer). Additionally, it is highly unlikely that drinking water wells would be installed at OU 3 in the surficial aquifer because the water yield from a well in the surficial aquifer

Table 2-3
Exposure Point Concentrations for Human Health Chemicals of Concern for Unfiltered Groundwater, Area B

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Concentration Detected		EPC[2]	Statistical Measure
		Minimum	Maximum		
Volatile Organic Compounds (Fg/R)					
1,1-Dichloroethene	1/1	3	3	3	Maximum
Tetrachloroethene	1/1	40	40	40	Maximum
Trichloroethene	1/1	9,800	9,800	9,800	Maximum

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).

[2] EPC is the lesser of either the arithmetic mean or maximum detected concentration.

Notes: PSCs = potential sources of contamination.
EPC = exposure point concentration.
Fg/R = micrograms per liter.

Table 2-4
Exposure Point Concentrations for Human Health Chemicals of Concern for Unfiltered Groundwater, Area C

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station, Jacksonville
Jacksonville Florida

Analyte	Frequency of Detection[1]	Concentration Detected		EPC[2]	Statistical Measure
		Minimum	Maximum		
Volatile Organic Compounds (Fg/R)					
Trichloroethene	5/5	42	5,000	1,700	Arithmetic Mean

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).

[2] EPC is the lesser of either the arithmetic mean or maximum detected concentration.

Notes: PSCs = potential sources of contamination.
EPC = exposure point concentration.
Fg/R = micrograms per liter.

Table 2-5
Exposure Point Concentrations for Human Health Chemicals of Concern for Unfiltered Groundwater, Area D

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station, Jacksonville
Jacksonville Florida

Analyte	Frequency of Detection[1]	Concentration Detected		EPC[2]	Statistical Measure
		Minimum	Maximum		
Volatile Organic Compounds (Fg/R)					
1,1-Dichloroethene	2/9	2	4.1	4.1	Maximum
Tetrachloroethene	8/9	0.55	34	8.4	Arithmetic Mean
Trichloroethene	9/9	540	6,800	4,100	Arithmetic Mean
Inorganic Compounds (Fg/R)					
Arsenic	2/2	10	23	17	Arithmetic Mean

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).

[2] EPC is the lesser of either the arithmetic mean or maximum detected concentration.

Notes: PSCs = potential sources of contamination.
Fg/R = micrograms per liter.
EPC = exposure point concentration.

Table 2-6
Exposure Point Concentrations for Human Health Chemicals of Concern for Unfiltered Groundwater, Area F

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Concentration Detected		EPC[2]	Statistical Measure
		Minimum	Maximum		
Volatile Organic Compounds (Fg/R)					
1,1-Dichloroethene	4/8	1	270	38	Arithmetic Mean
Trichloroethene	8/8	25	27,000	4,200	Arithmetic Mean
Vinyl chloride	1/8	2.8	2.8	2.8	Maximum

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).

[2] EPC is the lesser of either the arithmetic mean or maximum detected concentration.

Notes: PSCs = potential sources of contamination.
EPC = exposure point concentration.
Fg/R = micrograms per liter.

Table 2-7
Exposure Point Concentrations for Human Health Chemicals of Concern for Unfiltered Groundwater, Area G

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Concentration Detected		EPC[2]	Statistical Measure
		Minimum	Maximum		
<u>Volatile Organic Compounds</u> (Fg/R)					
1,1-Dichloroethene	2/4	380	760	290	Arithmetic Mean
1,2-Dichloroethene (total)	3/4	25	1,600	460	Arithmetic Mean
Trichloroethene	4/4	86	3,800	2,000	Arithmetic Mean
Vinyl chloride	3/4	13	66	30	Arithmetic Mean

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] EPC is the lesser of either the arithmetic mean or maximum detected concentration.

Notes: PSCs = potential sources of contamination.
EPC = exposure point concentration.
Fg/R = micrograms per liter.

Table 2-8
Exposure Point Concentrations for Human Health Chemicals of Concern for Storm Sewer Water

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Concentration Detected		EPC[2]	Statistical Measure
		Minimum	Maximum		
<u>Volatile Organic Compounds</u> (Fg/R)					
Trichloroethene[3]	8/19	1.5	170	170	Maximum

[1] Frequency of detection is the number of samples in which the analyte was detected over the total number of samples analyzed (excluding rejected values).
[2] EPC is the lesser of either the arithmetic mean or maximum detected concentration.
[3] Trichloroethene does not contribute to human health risk; however, the maximum detected concentration exceeds the Florida Surface Water Standards.

Notes: PSCs = potential sources of contamination.
% = percent.
UCL = upper confidence limit on the mean.
EPC = exposure point concentration.
Fg/R = micrograms per liter.

would not be sufficient to meet the consumptive needs for current NADEP, any other future NAS Jacksonville, or industrial activities. Exposure of potential future occupational workers to groundwater via ingestion of drinking water is, however, evaluated in the risk assessment as a conservative worst case measure.

Exposure of potential future occupational workers to contamination in groundwater via vapor migration into buildings is not considered in the risk assessment because the contribution from inhalation is insignificant compared to ingestion in the total risk calculation. Furthermore, the inhalation scenario was not considered because there is a lack of VOC detection in current ambient air monitoring in the buildings. The NAS Jacksonville Partnering Team desired to see a worst case groundwater ingestion pathway addressed, and FDEP has taken the position that Occupational Safety and Health Administration (OSHA) requirements are sufficient for the protection of indoor workers.

At OU 3 the future land uses and potentially complete exposure pathways include the following:

- occupational workers exposed to groundwater via limited ingestion of drinking water from hypothetical future drinking water wells (a showering scenario is not considered probable in this limited occupational setting, and dermal exposure via hand-washing would be minimal);

- utility workers exposed to storm sewer water via limited dermal contact with storm sewer water while maintaining or repairing the storm sewers (incidental ingestion of storm sewer water is not assessed because it is considered insignificant with good hygiene/work practices).

Toxicity Assessment. The purpose of the toxicity assessment is to identify the adverse effects that are associated with the COCs. Both carcinogenic and noncarcinogenic risk information is provided in Tables 2-9 and 2-10, respectively. Although the specific COCs are different for each of the hot spot areas, all COCs in groundwater and storm sewer water at OU 3 are included in these tables. The pathways for exposure include ingestion as drinking water and direct contact by a construction worker scenario.

Risk Characterization. Risk characterization involves the integration of the exposure and toxicity assessments into an expression of potential human health risks associated with contaminant exposure. Quantitative estimates of both carcinogenic and noncarcinogenic risks are made for each COC and each complete exposure pathway identified in the exposure assessment.

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. This value is a chemical-specific excess lifetime cancer risk (ELCR) and represents an upper bound of the probability of an individual developing cancer over a lifetime of exposure to a chemical. The ELCR is calculated from the following equation:

$$ELCR_i = CDI_i x CSF_i \qquad (1)$$

where: $ELCR_i$ = a unitless probability (e.g., $2x10^{-5}$) of an individual's developing cancer from exposure to chemical i,

Table 2-9
Cancer Toxicity Data Summary

Record of Decision
PSCs 11,12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Pathway: Ingestion, Dermal

CDC	Oral CSF	Dermal CSF	Species/Study/Tumor	Source	Wt. of Evidence
Arsenic	1.5E+00	1.5E+00	human/oral-DW/skin	IRIS	A
1,1-Dichloroethene	6.0E-01	6.0E-01	rat/oral-DW/adrenal	IRIS	C
Tetrachloroethene	5.2E-02	5.2E-02	(W1)(N1)	NCEA	B2
Trichloroethene	1.1E-02	1.1E-02	(W2)(N1)	HEAST	B2
Vinyl Chloride	1.9E+00	ND	rat/oral-diet/lung, liver	HEAST	A

Notes: PSCs = potential sources of contamination.
CSF = Cancer slope factor in $(mg/kg/day)^{-1}$.
Wt = weight.
IRIS = Integrated Risk Information System.
HEAST = Health Effects Assessment Summary Tables.
NCEA = National Center for Environmental Assessment (see U.S. Environmental Protection Agency Region 3 Risk-based Concentration Tables).
N1 = An NCEA provisional value provided upon request.
W1 = Value withdrawn from HEAST in 1992.
W2 = Value of 1.1E-02 withdrawn from HEAST in 1992.
A = Human carcinogen.
B2 = Probable human carcinogen - evidence in animals.
C = possible human carcinogen.
ND = not determined/no data.
DW = drinking water.
COC = chemical of concern.

Table 2-10
Noncancer Toxicity Data Summary

Record of Decision
PSCs 11,12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Pathway: Ingestion, Dermal

CDC	Oral RfD	Dermal RfD	Effect	Source	Date
Arsenic	3.0E-04	2.9E-04	keratosis/hyperpigmentation	Vahter	1983
1,1-Dichloroethene	9.0E-03	9.0E-03	hepatic lesions	Putcha	1986
1,2-Dichloroethene	9.0E-03	9.0E-03	liver lesions	[1]	--
Tetrachloroethene	1.0E-02	1.0E-02	hepatotoxicity	Pegg	1979
Trichloroethene	6.0E-03	6.0E-03	ND	Prout	1985

[1] = Value for 1,1-dichloroethene used as surrogate, based on structural analogy.

Notes: PSCs = potential sources of contamination.
COC = chemical of concern.
RfD = Reference dose in milligrams per kilogram per day.
ND = not determined/no data.

CDI_i = chronic daily intake of a chemical i averaged over 70 years (in milligrams per kilogram a day [mg/kg-day]),

CSF_i = USEPA cancer slope factor for chemical i $(mg/kg\text{-}day)^{-1}$.

These risks are probabilities that are expressed in scientific notation (e.g., $1x10^{-6}$). An excess lifetime cancer risk of $1x10^{-6}$ indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of a site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk range for site-related exposures is $1x10^{-4}$ to $1x10^{-6}$.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ < 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The hazard index (HI) is generated by adding the HQs for all chemicals of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI < 1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$\textit{Non-cancer } HQ = CDI/RfD \qquad (2)$$

where: CDI = chronic daily intake,
RfD = reference dose.

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

Table 2-11 provides the risk characterization results for groundwater and storm sewer water under future land use potential groundwater exposure scenarios.

At Area B, the cancer risk associated with groundwater ingestion by a potential future occupational worker is $4x10^{-4}$ primarily due to PCE, TCE and 1,1-DCE. The noncancer risk for the same use scenario has an HI of 16 mainly due to TCE.

At Area C, the cancer risk associated with groundwater ingestion by a potential future occupational worker is $7x10^{-5}$ primarily due to TCE. This is within the acceptable USEPA range of $1x10^{-4}$ to $1x10^{-6}$ but exceeds the FDEP level of concern of $1x10^{-6}$. The noncancer risk for the same use scenario has an HI of 3 mainly due to TCE.

Table 2-11
Risk Summary Future Land Use

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Land Use		Exposure Route	HI *	ELCR *
Groundwater Area B:				
	Occupational Worker			
		Ingestion of groundwater as drinking water	16	4×10^{-4}
		Total Occupational Worker:	16	4×10^{-4}
Groundwater Area C:				
	Occupational Worker			
		Ingestion of groundwater as drinking water	3	7×10^{-5}
		Total Occupational Worker:	3	7×10^{-5}
Groundwater Area D:				
	Occupational Worker			
		Ingestion of groundwater as drinking water	7	3×10^{-4}
		Total Occupational Worker:	7	3×10^{-4}
Groundwater Area F:				
	Occupational Worker			
		Ingestion of groundwater as drinking water	7	3×10^{-4}
		Total Occupational Worker:	7	3×10^{-4}
Groundwater Area G:				
	Occupational Worker	Ingestion of groundwater as drinking water	4	9×10^{-4}
		Total Occupational Worker:	4	9×10^{-4}
Sewer Water:				
	Utility Worker:	Dermal contact	0.1	3×10^{-7}
		Total Utility Worker:	0.1	3×10^{-7}

Notes: PSCs = potential sources of contamination.
HI = hazard index.
* = receptor totals may vary from spreadsheets due to rounding algorithm.
ELCR = excess lifetime cancer risk.

At Area D, the cancer risk associated with groundwater ingestion by a potential future occupational worker is $3x10^{-4}$ primarily due to arsenic, PCE, TCE and 1,1-DCE. The noncancer risk for the same use scenario has an HI of 7 mainly due to TCE, and to a lesser extent, arsenic.

At Area F, the cancer risk associated with groundwater ingestion by a potential future occupational worker is $3x10^{-4}$ primarily due to TCE, 1,1-DCE and VC. The noncancer risk for the same use scenario has an HI of 7 mainly due to TCE.

At Area G, the cancer risk associated with groundwater ingestion by a potential future occupational worker is $9x10^{-4}$ primarily due to TCE, 1,1-DCE and VC. The noncancer risk for the same use scenario has an HI of 4 mainly due to TCE.

In the storm sewer, the cancer risk for the potential utility worker exposed to the storm sewer water is $3x10^{-7}$ primarily due to TCE; and the noncancer risk is represented by an HI of 0.1. Neither of these risk values is unacceptable to USEPA or to FDEP, but the TCE concentration in the storm sewer water exceeds the Florida Surface Water Standards. Since the storm sewer water exceedances occur within the area of tidal fluctuations from the St. Johns River, they are subject to the Florida Surface Water Standards and must be addressed.

The overall assessment of human health risks from OU 3 can be summarized as negligible from soil, surface water, and storm sewer water. Also, although there are elevated risks from VOCs in groundwater, it is improbable that the contaminated surficial aquifer will become a potable water source in the future due to the fact that a potable public water source is currently available and the aquifer would not produce an adequate supply of water for NADEP activities.

PSC 48. No formal risk analysis was performed for PSC 48 because very high concentrations of chlorinated compounds were found in 1993 during the field program and again in 1995 during an engineering evaluation and cost analysis. The levels of the VOCs were as follows: PCE - 36,000 *µg/ℓ*, TCE - 11,000 *µg/ℓ*, DCE - 4,000 *µg/ℓ*, and vinyl chloride - 150 *µg/ℓ*. All of these compounds far exceed both State and Federal maximum contaminant levels (MCLs).

Due to these high concentrations in the groundwater, the risk to human health was also assumed to exceed the both Federal and State risk management guidelines for both current and future worker scenarios. Therefore, the NAS Jacksonville Partnering Team expedited remedial design and action for PSC 48.

Building 780. No formal risk analysis was performed for Building 780 because very high concentrations of chlorinated compounds were found when NADEP converted the building into a closed-loop solvent recycling facility in 1990/1991 and again in 1995 during the engineering evaluation and cost analysis. The levels in 1995 were as follows: trichloroethane - 260 *µg/ℓ*; dichloroethane - 8,900 *µg/ℓ*; chloroethane - 6,900 *µg/ℓ*; TCE - 870 *µg/ℓ*; DCE - 8,800 *µg/ℓ*; and vinyl chloride - 6,400 *µg/ℓ*. All of these compounds exceed both State and Federal MCLs.

Due to these high concentrations in the groundwater, the risk to human health was again assumed to exceed the both Federal and State risk management guidelines for both current and future worker scenarios. Therefore, the NAS Jacksonville Partnering Team expedited remedial design and action for Building 780.

Specific risk evaluations were conducted for PSCs 11, 12, 13, 14, and 15. The conclusions from these evaluations are summarized below.

PSC 11. As discussed in Section 2.4, since the tanks, piping, contaminated soil, and building structure were removed from the former plating shop area, there is no need for further cleanup. Likewise, even though contamination found in the eastern part of the jet line hangar during the 1993 field program was elevated above regulatory limits, based on the risk assessment, there was no unacceptable risk and no cleanup is required.

PSC 12. The soil at this PSC does not pose a risk to human health or the environment that requires cleanup (HLA, 1998a).

PSC 13. As discussed in Section 2.4, since the radium-contaminated soil and dials have been removed from the PSC, there is no longer a risk to human health or the environment.

PSC 14. The concentration of lead in the soil exceeds the acceptable level for residential development but is below the criteria for industrial usage. Since it is not anticipated that OU 3 will be used for residential development, the site conditions at PSC 14 pose no unacceptable risks to human health or the environment. LUCs will be used to limit future activities at PSC 14 (HLA, 1998b).

PSC 15. As discussed in Section 2.4, radium-contaminated soil at PSC 15 has been removed except beneath a thick concrete pad or deeper than 3 feet. There could be a risk to human health if persons unknowingly came into contact with the remaining contaminated soil. However, since the contaminated soil is beneath a thick concrete pad or is deeper than 3 feet, casual human or animal contact will not occur. Therefore, there is no unacceptable risk due to soil at PSC 15 unless the cover soils or concrete pad are removed. LUCs will be used to limit future activities at PSC 15.

2.7.2 Summary of the Ecological Risk Assessment The baseline ecological risk assessment provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline ecological risk assessment for this site.

Identification of Chemicals of Concern. Based on the results of the screening level ecological risk assessment (ERA) presented in the RI/FS, several contaminants that were detected in the sediment of the St. Johns River adjacent to OU 3 were retained for further evaluation. Those preliminary COCs include PAHs, cadmium, chromium, lead, mercury and silver.

Exposure Assessment. The majority of OU 3 is paved, and little, if any, terrestrial habitat is available at the site. At the southern end of the site, a small area of disturbed shrub habitat exists directly adjacent to the PSC l6 storm sewer outlet. It is estimated that only two to five percent of the entire site area of OU 3 is covered by shrub-like vegetation.

There is a small area of maintained grass directly north of the overgrown area. A grassy drainage ditch is located in this maintained area. The drainage ditch contains hydrophytic vegetation such as cattails and other reeds. However, it appears that the ditch remains dry for the majority of the year. It is believed that the ditch contains standing water only during periods of heavy rain.

There is no natural shoreline available at OU 3. The site is surrounded on the southern and eastern boundaries by man-made or altered shoreline.

Given the relative lack of terrestrial wildlife habitat at OU 3, it is expected that only small terrestrial mammals and birds would forage at the limited habitat available at the site. In addition, semiaquatic birds including seagulls and other avifauna are expected to occur in the immediate vicinity of OU 3. It should be noted, however, that due to the lack of available natural shoreline at OU 3, the presence of semiaquatic wading birds at or near OU 3 is unlikely. In addition, NAS Jacksonville has an active Bird Aircraft Strike Hazard Program which strives to dissuade birds from coming to runways and taxiways.

The St. Johns River estuary provides a valuable nursery habitat for many species of aquatic organisms. This estuarine environment is a productive fish ground that supports sport and commercial fishing. Bivalves and submerged aquatic vegetation were observed in a number of the sediment samples. An area of submerged aquatic vegetation approximately 3 acres in size was observed just south of the NAS Jacksonville boat dock, extending approximately 1,000 feet to the south. At the northern edge of the seawall, sea grasses were observed to extend approximately 10 to 20 feet from the wall.

Surface water runoff from OU 3 flows toward the river, which discharges to the Atlantic Ocean approximately 24 miles north and east of the facility. In general, the water quality of the St. Johns River is good. However, the St. Johns River Water Management District has rated the water quality of the river as poor in the urban reaches of Jacksonville. The river along OU 3 is rated as fair. The terms good, fair, or poor are subjective because they are based on a combination of national water quality criteria. The areas rated poor have low dissolved oxygen, high nutrients and bacteria, and some toxics problems, especially metals.

There are no records of rare, endangered, and/or threatened species occurrences at the site. However, the Florida Natural Areas Inventory (FNAI) noted that the shortnose sturgeon and little blue heron are known to occur within one mile of OU 3 (FNAI, 1997). The Florida Game and Freshwater Fish Commission (FGFFC) noted that tri-colored herons, bald eagles, ospreys, brown pelicans, diamondback terrapins, and West Indian manatees exist in close proximity to the site (FGFFC, 1997). Manatees have been observed in the St. Johns River adjacent to OU 3.

The exposure pathway includes a source of contamination, a receptor, potentially contaminated media, and an exposure route. The exposure pathways were evaluated in the screening-level ecological risk assessment and two were recommended for further evaluation in a baseline risk assessment. The selected exposure pathway and contaminants required for further evaluation is direct contact and indirect ingestion of PAHs and metals in the sediment by aquatic receptors. The site conceptual model for the baseline ecological risk assessment is shown in Figure 2-13.

<u>Ecological Effects Assessment</u>. The assessment end point chosen for the baseline ERA was the survival and growth of benthic and larval stage aquatic species. The measurement endpoints chosen are the chemical concentrations detected in sediment

at the two areas of concern that may he associated with adverse effects to the survival and growth of the marine amphipod, *Leptochierus plumulosus*, in site-specific sediment toxicity tests.

Sediment samples were collected at two areas of concern (i.e., the area east of the seawall and south of the old fuel dock and the area south of PSC 16) as well as a background location (i.e., upstream of OU 3 near the Station's officer housing). In addition to the toxicity testing, the samples were analyzed for PAHs, target analyte list (TAL) metals, total organic carbon (TOC), and grain size distribution.

Ecological Risk Characterization. At the area east of the seawall and south of the old fuel dock, concentrations of cadmium and mercury detected during the April 1998 sediment sampling event were elevated relative to the benchmark values and upgradient and clean background sediment. Sediment was recollected from this area in January 1999 for toxicity testing and concurrent analysis for cadmium and mercury.

Results of the chemical analysis indicate that detected concentrations of cadmium are similar to those found at location U3-SD-08 during the April 1998 sampling. Cadmium was detected at a concentration of 2.2 mg/kg during the April 1998 sampling; in the January 1999 sampling, cadmium was detected at two of the three locations at concentrations ranging from 1.6 to 3.1 mg/kg. Mercury, that was detected at a concentration of 0.62 mg/kg during the April 1998 sampling, was not detected in any of the three samples collected in January 1999.

The results of the toxicity testing show no significant mortality of *L. plumulosus* exposed to sediment from sampling locations U3-SD-14, U3-SD-15, and U3-SD-16; therefore, lethal risks are not predicted for aquatic receptors. The average growth of *L. plumulosus* exposed to sediment from the three locations ranged from 0.2094 to 0.2394 milligrams. These growth measurements are significantly different (P = 0.05) from growth observed at the site background location (0.3274 milligrams per organism), but not significantly different from growth observed in the laboratory control (0.1554 milligrams per organism). Although the toxicity testing results show significant differences in amphipod growth relative to the background sample, sublethal risks are not predicted because amphipod growth in the site-related samples exceeds that observed in the laboratory control. In addition, no reduction in amphipod weight was observed in the site-related samples.

Based on the weight of evidence for the area east of the seawall and south of the old fuel dock (toxicity testing results and concurrent chemical analyses), risks are not predicted for aquatic life exposed to sediment. Sediment collected from this area was not toxic to the amphipod in the laboratory toxicity tests and the concentrations of contaminants of concern generally decreased between the April 1998 and January 1999 sampling events.

At the area south of the PSC 16 storm sewer outlet, concentrations of PAHs and metals including cadmium, chromium, lead, and silver detected during the April 1998 sediment sampling event were elevated relative to the benchmark values and upgradient and clean background sediment. Sediment was recollected from this area in January 1999 for toxicity testing and concurrent analysis of PAHs and metals. Analytical results of PAHs and metals analysis is presented in Table 2-12. Sediment toxicity testing results are presented in Table 2-13.

Table 2-12
Summary of January 1999 Sediment Analytical Data [1]

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Analyte	PSC 16 Stormwater Outfall			Background
	U3-SD-11[2]	U3-SD-12	U3-SD-13	U3-SD-BK4
Polyaromatic Hydrocarbons (μg/kg)				
2-Methylnaphthalene	618	ND	ND	ND
Benzo(a)anthracene[3]	193	ND	ND	ND
Benzo(a)pyrene[3]	500	110	91	ND
Benzo(b)fluoranthene[3]	620	100	93	ND
Benzo(g,h,i)pyrene[3]	420	ND	73	ND
Benzo(k)fluoranthene[3]	285	ND	ND	ND
Chrysene[3]	615	ND	ND	ND
Dibenzo(a,h)anthracene[3]	153	95	ND	ND
Fluoranthene[3]	1,205	130	110	ND
Indeno(1,2,3-cd)pyrene[3]	260	ND	ND	ND
Naphthalene	573	ND	ND	ND
Phenanthrene	378	ND	ND	ND
Pyrene[3]	995	110	85	ND
Inorganic Analytes (mg/kg)				
Aluminum	816	663	2,040	438
Cadmium[3]	2.3	ND	0.88	ND
Calcium	3,625	68,700	ND	ND
Chromium[3]	25	7.5	14.3	1.7
Copper	12.3	5.7	57.2	ND
Iron	1,885	879	855	537
Lead[3]	127	26.8	44.2	1.9
Manganese	27.7	61.8	20	13.4
Mercury[3]	0.13	ND	0.16	ND
Nickel	16.3	7.2	7.4	ND
Silver[3]	ND	ND	ND	ND
Zinc	655	12.1	115	7.6
Total Organic Carbon (mg/kg)	2,700	4,100	3,500	2,300

[1] The analytical results of the January 1999 sediment sampling are presented in Appendix C of the Remedial Investigation and Feasibility Study (HLA, 2000a). Sample locations are depicted on Figure 7-6 in the same report.
[2] The reported detected concentration for sampling location U3-SD-11 is the average of sample U3-SD-11 and its duplicate U3-SD-11D.
[3] Listed as a preliminary contaminant of concern in Table 7-16 of the Remedial Investigation and Feasibility Study (HLA, 2000a).

Notes: PSC = potential source of contamination.
μg/kg = microgram per kilogram.
ND = not detected.
mg/kg = milligram per kilogram.

Table 2-13
Summary of Sediment Toxicity Testing Results[1]

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Sample Location	Survival (%)	Average Growth per Organism (mg)
Initial Tests[2]		
U3-SD-11	0[3,4]	no survival[3,4]
U3-SD-12	95	0.1988[4]
U3-SD-13	92	0.2098[4]
U3-SD-14	96	0.2394[4]
U3-SD-15	96	0.2281[4]
U3-SD-16	96	0.2094[4]
U3-SD-BK4 (site background)	99	0.3274
Laboratory Control	94	0.1554[4]
Supplemental Tests[2]		
U3-SD-11	0[3,4]	no survival[3,4]
U3-SD-12	79[3]	0.22
U3-SD-13	85	0.12
U3-SD-BK4 (site background)	83	0.18
Laboratory Control	93	0.20

[1] A complete report of the sediment toxicity testing results is included as Appendix K of the Remedial Investigation and Feasibility Study (HLA, 2000a).
[2] The initial testing was conducted between 22 January and 1 February 1999. Supplemental testing was done between 27 July and 6 August 1999 using collected sediment from the locations associated with the PSC 16 Outfall (i.e., U3-SD-11, U3-SD-12, U3-SD-13). The site background (i.e., U3-SD-BK4) and a laboratory control were also retested.
[3] There is a significant difference (P=0.05) between this sample and the laboratory control.
[4] There is a significant difference (P=0.05) between this sample and the site background sample, U3-SD-BK4.

Notes: % = percent.
mg = milligrams.
PSC = potential source of contamination.

Because the highest concentrations of PAHs and a number of metals were detected at location U3-SD-11 where 100 percent mortality was observed, the results of the sediment toxicity testing were compared to the concentrations of these constituents using simple linear regressions. An r value greater than 0.90 was considered to be representative of a strong relationship between a contaminant and a toxicological effect (i.e., mortality). Strong positive associations were found between mortality in *L. plumulosus* and total PAHs ($r^2 = 0.96$) and lead ($r^2 = 0.93$).

The results of the analytical data and toxicity tests indicate that the area of contaminated sediment contributing to macroinvertebrate toxicity is localized to a small area directly adjacent to the PSC 16 stormwater outfall. PAHs and lead appear to be the primary contaminants associated with this toxicity.

The source of PAH contamination in the St. Johns River is unclear. The presence of PAHs in sediment adjacent to the outfall may be the result of a one-time historical release from the PSC 16 outfall or a release from an adjacent storm sewer located south of the Kemen Test Cell and directly to the east of the PSC 16 outfall. The presence of "tar balls" observed during the April 1999 depositional characterization also suggests that a previous release of hydrocarbons may have occurred from one of the outfalls that discharge to the St. Johns River south of OU 3.

Based on the weight of evidence for the area south of the PSC 16 storm sewer outfall (toxicity testing results and concurrent chemical analyses), risks are predicted for aquatic receptors exposed to sediment at location U3-SD-11, which is located directly adjacent to the PSC 16 stormwater outfall. In the laboratory toxicity tests, 100 percent mortality was observed in amphipods exposed to sediment from this sampling location. Based on the results of linear regressions, the observed toxicity is positively associated with detected concentrations of PAHs and lead in the sediment.

2.7.3 Basis for Action. The human health risk assessment indicates that there is an unacceptable potential risk to human health because of the groundwater contamination at Areas B, C, D, F and G. The ecological risk assessment indicates that the sediment at the PSC 16 outfall has unacceptable contamination due to the presence of "tar balls" in the sediment. Furthermore, the TCE concentrations in the storm sewer water exceed the Florida Surface Water Standards. These unacceptable risks to human health and the environment as well as the exceedances of surface water standards form the basis for the actions proposed in this ROD.

2.8 REMEDIAL ACTION OBJECTIVES. Based on the results of field investigations and risk assessments conducted during the OU 3 RI and in conjunction with the evaluation of legal requirements that may be ARARs for this site, remedial action objectives (RAOs) were established for the OU. RAOs are cleanup objectives designed to protect human health and the environment and to comply with State and Federal requirements. RAOs are developed for areas within OU 3 which were found to have risk to human or ecological receptors. Ultimately, the overall strategy at OU 3 is to devise and implement cleanup remedies which minimize the need for LUCs or other administrative controls. Therefore, the basis and rationale for developing RAOs for storm sewer water, groundwater, and sediment was to bring storm sewer water effluent into compliance with Florida Surface Water Standards

(FSWS), to make groundwater suitable for drinking water purposes, and to remove ecological mortality risk in sediment. Hence, RAOs were established for storm sewer water due to a maximum detected concentration of TCE that exceeded the FSWS. RAOs for groundwater were established because of the excessive human health risk due to chlorinated VOC concentrations above Federal and State MCLs. RAOs for sediment were established due to a small area of lethal toxicity to aquatic receptors. A brief synopsis of these objectives is provided in Table 2-14. The objectives are intended to be the design basis for a final remedy for media at OU 3.

Table 2-14
Remedial Action Objectives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Medium	Contaminants Causing Unacceptable Risks	Remedial Action Objectives
Storm Sewer Water	TCE	Manage contaminated storm sewer water to achieve Florida Surface Water Standards within the zone of tidal influence.
Groundwater	Chlorinated VOCs	Address groundwater contamination at Areas B, C, D, F, and G containing concentrations of chemicals above ARARs.
Sediment	PAHs Lead	Reduce ecological receptor exposure to sediment containing lethal concentrations of PAHs and lead.

Notes: OU = operable unit.
PSC = potential source of contamination.
VOC = volatile organic compound.
ARARs = applicable or relevant and appropriate requirements.
TCE = trichloroethene.
PAHs = polycyclic aromatic hydrocarbons.

RAOs were not established for soil or surface water at OU 3 because no risks were predicted for human or ecological receptors exposed to those media.

<u>2.9 DESCRIPTION OF ALTERNATIVES</u>. Various cleanup alternatives that would achieve the RAOs for the storm sewer water, groundwater, and sediment at OU 3 were evaluated. These cleanup alternatives were developed by the U.S. Navy, the USEPA, and the FDEP. The selected alternative(s) for each media is intended to be a final remedy.

<u>2.9.1 Description of Remedy Components</u> An overview of the alternatives developed for each media is presented below, and the key components of each alternative are described in Table 2-15.

Storm Sewer Water:

The portion of the OU 3 storm sewers to be addressed by a selected remedial action is shown in Figure 2-17 (the portion of the storm sewer from MH2 to the

Table 2-15
Remedial Alternatives Evaluated for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Storm Sewer Water Alternatives	Description of Key Components
No Action	Storm sewer water monitoring. Five-year reviews.
Cured-in-Place Pipe	Installation of cured-in-place pipe. Storm sewer monitoring. Five-year reviews.
Groundwater Alternatives	**Description of Key Components**
No Action	Groundwater use restrictions, monitoring, and five-year reviews.
Natural Attenuation	Groundwater monitoring for contaminants and biodegradation parameters. Modeling of groundwater flow and degradation processes. Groundwater use restrictions, and five-year reviews.
Enhanced Biodegradation	Installation of a HRC™ injection system. Groundwater monitoring for contaminants and biodegradation parameters. Treatability studies. Groundwater use restrictions, and five-year reviews.
Extraction and Treatment	Groundwater extraction. Pretreatment of extracted groundwater via packed tower air stripping or UV/OX. Discharge of pretreated groundwater to the facility's FOTW. Treatability studies and treatment system monitoring. Groundwater use restrictions, monitoring, and five-year reviews.
Air Sparging	Air sparging. Soil vapor extraction with temporary GAC treatment (if necessary). Treatability studies and treatment system monitoring. Groundwater use restrictions, monitoring, five-year reviews.
Chemical Oxidation	Groundwater extraction and oxidant injection. In situ chemical oxidation. Treatability studies and treatment system monitoring. Groundwater use restrictions, monitoring, and five-year reviews.
Sediment Alternatives	**Description of Key Components**
No Action	None.

See notes at end of table.

Table 2-15 (Continued)
Remedial Alternatives Evaluated for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Sediment Alternatives	Description of Key Components
Dredging	Sampling to confirm remediation boundaries. Installation of a containment barrier. Dredging and disposal of sediment. Confirmatory sediment sampling.
Selective Removal of Tar Balls	Sampling to confirm remediation boundaries. Installation of a containment barrier. Selective removal and disposal of tar balls in sediment. Confirmatory sediment sampling.

Notes: OU = operable unit.
HRC™ = hydrogen release compound.
UV/OX = ultraviolet light and oxidation.
PSCs = potential sources of contamination.
FOTW = federally owned treatment work.
GAC = granular activated carbon.

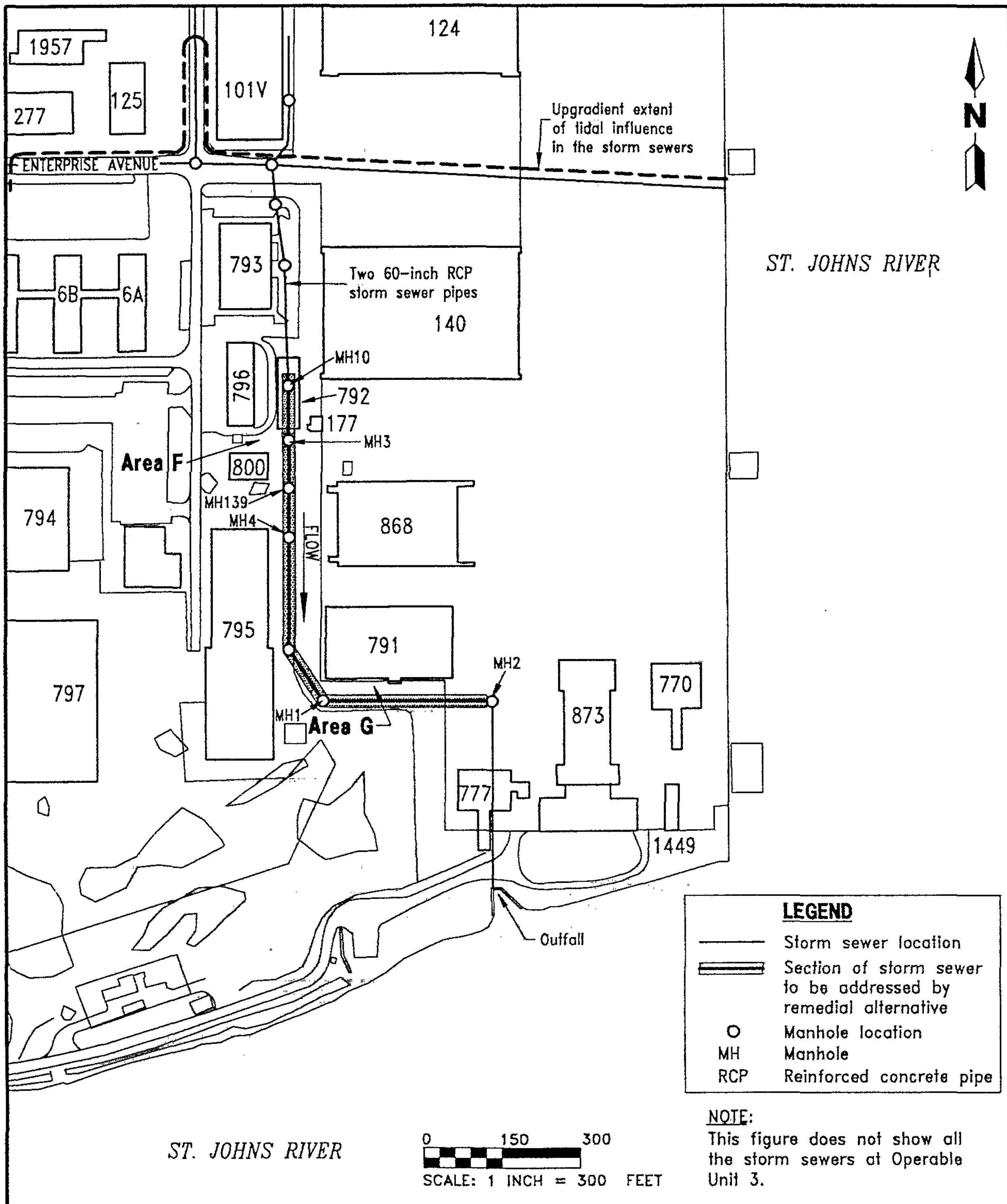

FIGURE 2-17
PORTION OF STORM SEWERS TO BE ADDRESSED BY REMEDIAL ALTERNATIVE

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outfall was lined with CIPP in 1996). Elevated concentrations of VOCs have been detected in the storm sewer water within the portion of the sewers that is influenced by tidal fluctuations of the St. Johns River (Figure 2-17). Specifically, TCE was detected at concentrations exceeding the Florida Surface Water Standard. The following two remedial alternatives were developed for storm sewer water at OU 3:

No Action: Because hazardous contaminants would be left in place as part of the no action alternative, it includes administrative actions (storm sewer water monitoring and five-year reviews).

Cured-In-Place Pipe: This alternative consists of relining a portion of the storm sewers to abate the suspected source of the contamination - groundwater infiltration. CIPP is felt tubing saturated with a thermosetting resin that is cured to the inner walls of the leaking sewer pipe. This alternative also includes storm sewer water monitoring and five-year reviews. The monitoring will occur at the manholes identified in Figure 2-17.

Groundwater:

The individual alternatives for groundwater at OU 3 were developed separately in the FS for Areas B, C, D, F, and G, as the nature and extent of the contamination and site conditions at each area are unique. A summary of the alternatives developed for groundwater at Areas B, C, D, F, and G is presented in Table 2-16.

Table 2-16
Remedial Alternatives Evaluated for Groundwater at OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

	No Action	Natural Attenuation	Enhanced Biodegradation	Extraction and Treatment	Air Sparging	Chemical Oxidation
Area B	X		X	X		X
Area C	X		X	X		
Area D	X		X	X		
Area F	X	X			X	X
Area G	X	X			X	X

Notes: OU = operable unit.
PSC = potential source of contamination.

The following is a general description of each remedial alternative that was developed for groundwater at OU 3:

No Action: Because hazardous contaminants would be left in place as part of the no action alternative, it includes administrative actions (groundwater monitoring, groundwater use restrictions, and five-year reviews).

A memorandum of agreement (MOA) between the USEPA, FDEP and U.S. Department of the Navy was signed on August 31, 1998 (USEPA, et al., 1998). The purpose of the MOA is to ensure compliance with LUCs (either already in place, or selected for future remedial action) to protect human health and the environment from exposure to contaminated media at NAS Jacksonville. Therefore, groundwater use restrictions at OU 3 shall be identified and enforced under the guidelines of the MOA.

Natural Attenuation: This alternative will be achieved by the reduction of VOCs in groundwater through natural biological, chemical, and physical processes occurring in the shallow zone of the surficial aquifer at OU 3. Indigenous microorganisms use natural organic carbon as substrate (food), to reduce contaminant concentrations through metabolic activity. Physical processes such as volatilization, sorption, advection, and dispersion further reduce contaminant concentrations naturally within the aquifer.

The natural attenuation alternative includes groundwater monitoring (for biodegradation parameters), groundwater use restrictions, groundwater modeling, and five-year reviews.

Enhanced Biodegradation: This alternative consists of injecting a carbon source, such as the polylactate ester HRC™, into a groundwater plume to stimulate bacterial growth and enhance natural biodegradation of chlorinated compounds. In addition, this alternative includes groundwater monitoring for contaminants and biodegradation parameters, treatability studies to collect information for design of the HRC™ injection system, groundwater use restrictions, and five-year reviews.

Extraction and Treatment: This alternative includes pumping out the contaminated groundwater, pretreating the extracted groundwater, and discharging to the NAS Jacksonville federally owned treatment works (FOTW) for further treatment. Two technologies for pretreatment of the extracted groundwater were evaluated in the feasibility study report for OU 3: air stripping and ultraviolet light and oxidation (UV/OX).

Air stripping transfers VOCs in the extracted groundwater from the liquid to the vapor phase by contacting the water with a continuous supply of clean air. UV/OX uses a combination of UV lamps and an oxidant, such as hydrogen peroxide, to destroy organic contaminants in the extracted groundwater. After being pretreated by either air stripping or UV/OX, the extracted groundwater would be discharged through NAS Jacksonville's sanitary sewer system to the FOTW for further treatment.

In addition to groundwater extraction, pretreatment, and discharge to the FOTW, this alternative includes treatability studies to collect information for design of the groundwater extraction and pretreatment systems, treatment system monitoring, groundwater use restrictions, groundwater monitoring, and five-year reviews.

Air Sparging: The air sparging alternative consists of injecting air into groundwater to create turbulence in the groundwater and enhance volatilization of the organic contaminants. For an area in which contaminated groundwater is overlain by buildings or pavement, this alternative includes collection of the generated vapors from the overlying soil by a soil vapor extraction (SVE) system. This alternative also includes treatability studies to collect information for design of the air sparging and SVE systems, groundwater monitoring, groundwater use restrictions, treatment system monitoring, and five-year reviews.

Chemical Oxidation: The chemical oxidation alternative consists of the injection of an oxidant such as potassium permanganate ($KMnO_4$) into the groundwater to chemically destroy the VOCs. A combination of groundwater extraction and injection wells would be used for chemical oxidation. Groundwater is extracted, dosed with oxidant, and then reinjected at an upgradient location. This allows flushing of the contaminated zone until the VOCs are oxidized. Prior to implementing this alternative, pilot-scale treatability studies would be conducted to establish: 1) the feasibility of injecting and adequately distributing the oxidant solution through the zone of contaminated groundwater; 2) an estimate of VOC destruction efficiency; and 3) the optimum concentration of oxidant in the solution. Other components of the chemical oxidation alternative are treatment system monitoring, groundwater use restrictions, groundwater monitoring, and five-year reviews.

Sediment:

The area of OU 3 sediment to be addressed by the selected remedial action is shown in Figure 2-18. The following three remedial alternatives were developed for sediment at OU 3:

No Action: Under the no action alternative for sediment at OU 3, no remedial action, engineering controls, or administrative actions will be taken to achieve the established RAO. This alternative was used as a baseline for comparison against the other sediment alternatives that incorporate remedial actions.

Dredging: This alternative consists of environmental dredging to remove contaminated sediment from the bottom of the St. Johns River, adjacent to the PSC 16 storm water outfall. The proposed dredging area encompasses the locations at which tar balls were observed during the sediment sampling events. The initial step of this alternative is collection of sediment samples and analysis for PAHs, lead, grain size, and total organic carbon, and toxicity testing, to better establish the limits of remediation.

As agreed upon by the NAS Jacksonville Partnering Team, the sediment would be dredged to a uniform depth of 6 inches within the remediation boundaries. For the assumed excavation boundary shown on Figure 2-18, the total volume of sediment to be removed is approximately 300 cubic yards.

Dredging may potentially resuspend contaminated sediment. Therefore a silt screen containment barrier will be installed around the dredging boundary to limit offsite migration of any suspended sediment. The dredged sediment slurry would be allowed to settle, so that the decanted water could be drained back to the St. Johns River, and the sediment could be transported to an offsite disposal facility. After dredging has been completed, confirmatory sediment sampling will be performed to confirm removal of the contaminated sediments. Backfilling may be required if sediments are contaminated deeper than expected.

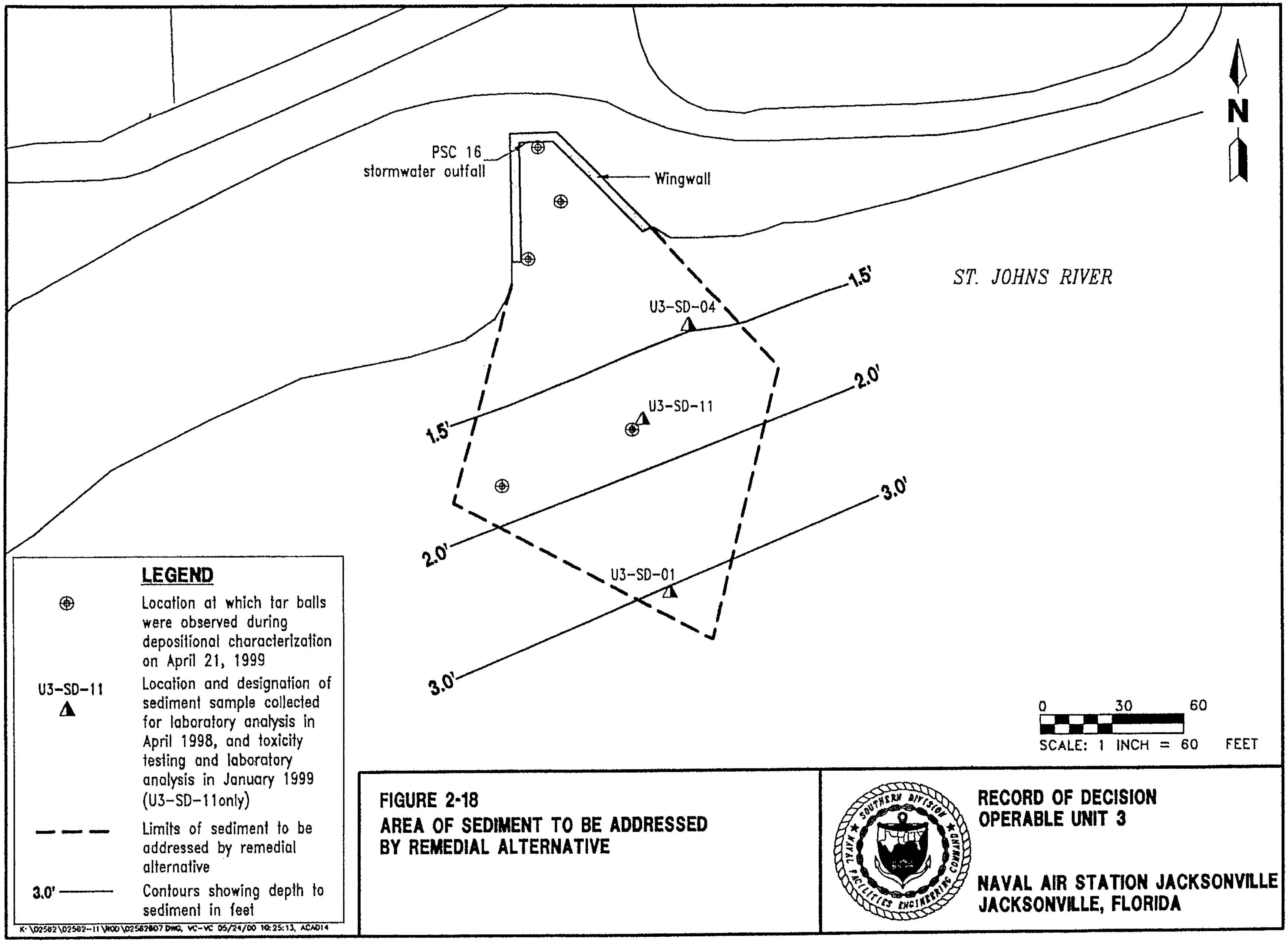

FIGURE 2-18
AREA OF SEDIMENT TO BE ADDRESSED BY REMEDIAL ALTERNATIVE

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JACKSONVILLE, FLORIDA

Selective Removal of Tar Balls: This alternative involves sifting through the sediment with a raking device to remove the embedded tar balls. Similar to dredging, this alternative includes collection of sediment samples and analysis for PAHs, lead, grain size, and total organic carbon, and toxicity testing, to better establish the limits of remediation. A silt screen containment barrier will be installed around the remediation boundary to limit offsite migration of any suspended sediment. The extracted tar balls would be containerized and disposed at an offsite disposal facility. It is assumed that the extracted tar balls could be placed in one 55-gallon drum for disposal. After the tar ball removal activities have been completed, confirmatory sediment sampling will be performed to confirm removal of the contaminated sediments. Backfilling could be required if the tar balls are deeper than what was found in 1999.

2.9.2 Common Elements and Distinguishing Features of Each Alternative The alternatives evaluated for each contaminated media at OU 3 share basic similarities:

- Storm sewers: Both alternatives considered for the storm sewers include storm sewer water monitoring and five-year site reviews.

  The key ARARs associated with the storm sewer water alternatives for OU 3 are the Florida Surface Water Standards (see Table 2-17 and Table 2-18).

- Groundwater: Each alternative considered for OU 3 groundwater includes groundwater monitoring, five-year site reviews, and groundwater use restrictions, to be enforced under the guidelines of the MOA between the USEPA, FDEP and U.S. Department of the Navy.

  As indicated in Table 2-16, the extraction and treatment alternative was considered for each hot spot area with groundwater contamination in the intermediate zone of the shallow aquifer (Areas B, C, and D), due to the high extraction rates demonstrated in that portion of the aquifer. Enhanced biodegradation was also considered for intermediate zone contamination at Areas B, C, and D, due to the potential for enhancing anaerobic biodegradation with the injection of a carbon source.

  Natural attenuation was evaluated for the areas with groundwater contamination in the shallow zone of the surficial aquifer (Areas F and G) because monitoring has shown that ongoing natural biodegradation is occurring in the upper surficial zone.

  The key ARARs driving the development of each groundwater alternative evaluated at OU 3 are the Florida Maximum Contaminant Levels (MCLs) (see Table 2-19). In the absence of a Florida MCL for a particular chemical detected in groundwater, the Federal MCL is used as the action level. For chemicals with neither a State nor Federal MCL, the Florida Groundwater Guidance Concentrations or the USEPA Region III Risk-Based Concentrations determine the action level for a particular chemical of concern (refer to Table 2-20).

Table 2-17
Key ARARs for Storm Sewer Water

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
Federal ARARs			
Clean Water Act (CWA), National Permit Discharge Elimination System (NPDES) (40 CFR Part 122 and 125)	Requires permits for discharge of any pollutant into the navigable waters of the United States. Permits specify allowable concentrations of contaminants that may be present in the effluent stream.	Because Naval Air Station Jacksonville is a CERCLA site, only the substantive requirements of attaining a NPDES permit is required for remedial alternatives that involve discharging pollutants to navigable waters.	Action-specific
National Environmental Policy Act Wetlands, Floodplains, Important Farmland, Coastal Zones, etc. (40 CFR Part 6)	Appendix A sets forth the policy for carrying out the Floodplains Executive Order 11988. This appendix requires cleanup in a floodplain not be selected unless determination is made that no practicable alternative exists.	If a remedial action will be implemented in a designated floodplain, alternatives should be considered to reduce the risk of flood loss and preserve and restore floodplains.	Location-specific
RCRA Regulations, Releases from Solid Waste Management Units (SWMUs) (40 CFR Part 264, Subpart F)	This rule establishes the requirements for SWMUs, and encompasses groundwater protection standards, concentration limits, point of compliance, compliance period, and requirements for groundwater monitoring.	The rule is relevant and appropriate for CERCLA sites contaminated with RCRA hazardous constituents.	Action-specific
State ARARs			
Florida Surface Water Quality Standards (Chapter 62-302, FAC)	Rule distinguishes surface water into five classes based on designated uses and establishes ambient water quality standards (called Florida Water Quality Standards) for listed pollutants.	Because these standards are specifically tailored to Florida waters, they should be used to establish cleanup levels rather than the Federal Ambient Water Quality Criteria.	Chemical-specific
Florida Wastewater Facility Permit (Chapter 62-620, FAC)	Establishes requirements for wastewater permits. Because Florida is a designated state (i.e., has the authority to implement the permits), one permit will suffice to meet both Federal and State discharge requirements.	If a remedial alternatives consists of the discharge of wastewater to navigable waters, the substantive requirements of this rule will need to be achieved.	Action-specific
Florida Water Quality Based Effluent Limitations (WQBELs) (Chapter 62-650, FAC)	Requires that all activities and discharges, except dredge and fill, must meet effluent limitations based on technology or water quality. WQBELs are determined by FDEP based on the characteristics of the receiving water, and the surface water criteria promulgated by FDEP.	The regulation will apply to remedial alternatives that discharge contaminated groundwater to surface water.	Chemical-specific

Notes: PSCs = potential sources of contamination.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
FDEP = Florida Department of Environmental Protection.
ARARs = applicable or relevant and appropriate requirements.
CFR = Code of Federal Regulations.
RCRA = Resource Conservation and Recovery Act.
FAC = Florida Administrative Code.

Table 2-18
Summary of Exceedances of ARARs/TBCs for Storm Sewer Water

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Detected Concentrations	Florida Surface Water Standard[2]
Volatiles (Fg/R)			
Trichloroethene	8/19	1.5 to 170	80.7

[1] Frequency of detection is the number of confirmatory samples in which the analyte was detected versus the total number of confirmatory samples analyzed.
[2] Values are for Class III Fresh water.

Notes: Fg/R = micrograms per liter.
ARARs = applicable or relevant and appropriate requirements.
TBCs = to be considered.
PSC = potential source of contamination.

Table 2-19
Key ARARs for Groundwater

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
Federal ARARs			
Clean Water Act (CWA), Water Quality Standards (40 CFR Part 131)	Ambient Water Quality Criteria (AWQC), which are non-enforceable, ecological- and human health-based criteria, have been developed to establish water quality standards under the CWA.	Remedial actions that involve the discharge of groundwater to a surface water body must consider the Federal AWQC in the absence of a state surface water standard.	Chemical-specific
CWA, General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR Part 403)	Regulations for the introduction of pollutants from nondomestic sources into wastewater treatment plants (either Publicly or Federally Owned Treatment Works [POTW or FOTW]) to control pollutants that pass through, cause interference, or are otherwise incompatible with treatment processes at the plant.	If extracted and treated groundwater is discharged to a POTW or FOTW, the discharge must meet local limits imposed by the plant.	Action-specific
Endangered Species Act Regulations (50 CFR Parts 81, 225, 402)	The Act requires Federal agencies to take action to avoid jeopardizing the continued existence of federally listed endangered or threatened species.	Endangered or threatened species may be present in the vicinity of OU 3. If a planned remedial action could potentially affect an endangered species, this regulation will apply.	Location-specific
Resource Conservation and Recovery Act (RCRA) Regulations, Identification and Listing of Hazardous Wastes (40 CFR Part 261)	Defines listed and characteristic hazardous wastes subject to RCRA. Appendix II contains the Toxicity Characteristic Leaching Procedure.	Based on the history of operations at OU 3 and the solvents used during operations, any investigative-derived waste would be analyzed and classified prior to disposal.	Chemical-specific Action-specific
RCRA Regulations, Releases from Solid Waste Management Units (SWMUs) (40 CFR Part 264, Subpart F	This rule establishes the requirements for SWMUs, and encompasses groundwater protection standards, concentration limits, point of compliance, compliance period, and requirements for groundwater monitoring.	The rule is relevant and appropriate for CERCLA sites contaminated with RCRA hazardous constituents.	Action-specific
RCRA Regulations, LDRs (40 CFR Part 268)	This regulation establishes restrictions on land disposal of untreated hazardous wastes and provides standards for treatment of hazardous waste prior to land disposal.	Any investigative-derived wastes generated as a result of remedial actions would be analyzed and characterized prior to disposal. Remedial alternatives that generate a wastestream requiring offsite disposal (e.g., spent carbon filters or exchange resins from treatment of extracted groundwater) will need to achieve the LDRs.	Action-specific
Safe Drinking Water Act (SDWA) Regulations, Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) (40 CFR Part 141, Subparts B and F)	Establishes enforceable standards (MCLs) for potable water for specific contaminants that have been determined to adversely affect human health. MCLGs are nonenforceable health goals established by USEPA.	MCLs can be used for groundwater or surface waters that are current or potential drinking water sources. Non-zero MCLGs can be considered potential relevant and appropriate requirements for groundwater used as a current or potential drinking water source.	Chemical-specific

See notes at end of table.

Table 2-19 (Continued)
Key ARARs for Groundwater

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
SDWA Regulations, Underground Injection Control Program (40 CFR Parts 144, 146, 147, and 1000)	These regulations outline minimum program and performance standards for underground injection programs.	If a remedial alternative for OU 3 includes injection into the aquifer, then these regulations will apply.	Action-specific
State ARARs			
Florida Rules on Permits (Chapter 62-4, Florida Administrative Code [FAC])	Provides permitting requirements for water pollution sources and air emissions units.	The regulation will apply to offsite CERCLA activities requiring air emissions or water discharge permits.	Action-specific
Florida Groundwater Classes, Standards and Exemptions (Chapter 62-520, FAC)	Rule designates the groundwater of the State into five classes and establishes minimum "free from" criteria. Rule also specifies that class I & II waters must meet the primary and secondary drinking water standards listed in Chapter 62-550, FAC.	These regulations should be used when determining cleanup levels for groundwater.	Chemical-specific
Florida Underground Injection Control Regulations (Chapter 62-522, FAC)	This rule establishes a State underground injection control program consistent with the Federal requirements and appropriate to the hydrogeology of Florida. Five classes of injection wells are defined.	If a remedial alternative for OU 3 includes injection into the aquifer, then these regulations will apply.	Action-specific
Florida Drinking Water Standards (Chapter 62-550, FAC)	Rule adopts Federal primary and secondary drinking water standards and also creates additional rules to fulfill State and Federal requirements for community water distribution systems.	The standards provided in this rule will be used when evaluating cleanup levels for groundwater at OU 3.	Chemical-specific
Pretreatment Requirements for Existing and New Sources of Pollution (Chapter 62-625, FAC)	Rule establishes the authority of various bodies to implement pretreatment standards to control pollutants that pass through or interfere with treatment processes in domestic wastewater facilities.	The regulation will apply to remedial activities involving the discharge of remediation waters to a POTW or FOTW.	Chemical-specific
Hazardous Waste Rules (Chapter 62-730, FAC)	These rules adopt by reference appropriate sections of 40 CFR Parts 260 through 268 and established minor additions and exceptions to these regulations concerning the generation, storage, treatment, transportation, and disposal of hazardous waste.	Based on the history of operations at OU 3 and the solvents used during operations, any investigative-derived waste would be analyzed and classified prior to disposal.	Action-specific

Notes:
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
USEPA = U.S. Environmental Protection Agency
ARARs = applicable or relevant and appropriate requirements.
CFR = Code of Federal Regulations.
LDRs = Land Disposal Restrictions.
OU = operable unit.
POTW = publically owned treatment works
FOTW = federally owned treatment works.
PSCs = potential sources of contamination.

Table 2-20
Summary of Exceedances of ARARs/TBCs for Groundwater Areas B, C, D, F, and G

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Detected Concentrations	Florida Standard[2]	Federal MCL[3]	Florida Guidance Concentration[4]	RBC for Tap Water[5]	Basewide Background Concentration[6]
Area B							
Volatile Organic Compounds (Fg/R)							
Chloromethane	2/7	1.1 to 14	NA	NA	**2.7**	NA	NA
Tetrachloroethene	1/7	40 to 40	**3**	5	3	1.1	NA
Trichloroethene	3/7	2.3 to 9,800	**3**	5	5	1.6	NA
Area C							
Volatile Organic Compounds (Fg/R)							
Methylene Chloride	1/10	27 to 27	**5**	5	5	4.1	NA
Trichloroethene	6/11	10 to 5,000	**3**	5	5	1.6	NA
Area D							
Volatile Organic Compounds (Fg/R)							
1,2-Dichloroethene (total)	8/9	0.63 to 190	**[7]70**	[7]70	[7]70	55	NA
Methylene Chloride	5/9	0.4 to 11.25	**5**	5	5	4.1	NA
Tetrachloroethene	8/9	0.55 to 34	**3**	5	3	1.1	NA
Trichloroethene	9/9	92 to 6,800	**3**	5	5	1.6	NA
Inorganic Analytes (Fg/R)							
Manganese	2/2	207 to 662	[8]50	[9]50	50	[10]5,100	**204**
Area F[11]							
Volatile Organic Compounds (Fg/R)							
1,1-Dichloroethene	2/7	1 to 270	**7**	7	7	0.044	NA
Tetrachloroethene	2/7	1.4 to 7.3	**3**	5	3	1.1	NA
Trichloroethene	6/7	12 to 3,000	**3**	5	3	1.6	NA
Vinyl Chloride	2/7	2.8 to 3.4	**1**	2	1	0.019	NA
Area G							
Volatile Organic Compounds (Fg/R)							
1,1,1-Trichloroethene	2/8	11 to 570	**200**	200	200	540	NA

See notes at end of table.

Table 2-20 (Continued)
Summary of Exceedances of ARARs/TBCs for Groundwater Areas B, C, D, F, and G

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Analyte	Frequency of Detection[1]	Range of Detected Concentrations	Florida Standard[2]	Federal MCL[3]	Florida Guidance Concentration[4]	RBC for Tap Water[5]	Basewide Background Concentration[6]
Area G							
<u>Volatile Organic Compounds</u> (Fg/R)--continued							
1,1,2-Trichloroethene	1/8	5.1 to 5.1	**5**	5	5	0.19	NA
1,1-Dichloroethene	3/8	0.77 to 760	**7**	7	7	0.044	NA
1,2-Dichloroethene (total)	3/8	25 to 1,600	**[7]70**	[7]70	[7]70	55	NA
Benzene	1/8	1.1 to 1.1	**1**	5	1	0.36	NA
Trichloroethene	7/8	1.5 to 3,800	**3**	5	3	1.6	NA
Vinyl Chloride	3/8	1.6 to 66	**1**	2	1	0.019	NA

[1] Frequency of detection is the number of groundwater samples in which the analyte was detected versus the total number of samples analyzed.
[2] Florida Standards are taken from Chapters 1 and 2 (Primary and Secondary Standards) of the Florida Department Environmental Protection (FDEP) Groundwater Guidance Concentrations (June 1994).
[3] Federal MCLs are taken from U.S. Environmental Protection Agency (USEPA) Drinking Water Regulations and Health Advisories (October 1996).
[4] Florida Guidance Concentrations are taken from Chapter 6 (Guidance Concentrations Index) of the FDEP Groundwater Guidance Concentrations (June 1994).
[5] Risk-based concentrations are taken from USEPA Region III RBCs table, dated April 1998. Screening values are calculated based in a cancer risk of 10^{-6} and a HI of 1. For essential nutrients (calcium, magnesium, sodium, and potassium) screening values were derived based on recommended daily allowances (RDAs).
[6] Basewide background concentrations were developed as part of the RI/FS for Operable Unit 1, Naval Air Station Jacksonville (ABB-ES 1996). Details of the background sampling program can be found in the OU 1 RI/FS report.
[7] Criteria shown are for cis-1,2-Dichloroethene.
[8] Value is a Florida secondary MCL.
[9] Value is a Federal secondary MCL.
[10] RBC is based on Manganese as a food.

Notes continued on next page.

Table 2-20 (Continued)
Summary of Exceedances of ARARs/TBCs for Groundwater Areas B, C, D, F, and G

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

[11] A total VOC concentration of 27,028 Fg/R was detected in a hydrocone sample at F01 in Area F, but was not duplicated in samples collected from monitoring well GEW003, 5 feet away. The hydrocone sample was collected over a discreet vertical interval of about 1 foot, whereas the monitoring well sample is homogenized over the length of the well screen, at least 10 feet. After pumping groundwater from GEW003 for 72 hours as part of a groundwater extraction pilot study at Area F, the maximum TCE concentration was 1,400 Fg/R, considerably lower than the concentration of TCE detected in F01. Therefore, the analytical results for F01 are not included for Area F, as the results from GEW003 are considered more representative of the aquifer conditions.

Notes: The selected action levels (bold and shaded values) for groundwater were determined as follows:

For organic chemicals, the selected criteria was established as

- the Florida Standard, if available
- if a chemical did not have a Florida Standard, then the Federal MCL (if available) was used
- if a chemical did not have a Florida Standard or a Federal MCL, then the higher value of the Florida Groundwater Guidance Concentration and the USEPA Region III RBC was used

For inorganic chemicals, the selected criteria was established as:

- the higher value of the Florida Standard (if available) and the background concentration
- if a chemical did not have a Florida Standard, then the higher value of the Federal MCL (if available) and the background concentration was used
- if a chemical did not have a Florida Standard or a Federal MCL, then the higher value of the Florida Groundwater Guidance Concentration, the USEPA Region III RBC, or the background concentration was used

MCL = maximum contaminant level.
NA = not applicable.
RBC = risk-based concentration.
Fg/R = micrograms per liter.
RI/FS = remedial investigation and feasibility study.
ABB-ES = ABB Environmental Services, Inc.
OU = operable unit.
VOC = volatile organic compound.
TCE = trichloroethene.
ARARs = applicable or relevant and appropriate requirements.
TBC = to be considered.
PSC = potential source of contamination.
HI = hazard index.
PSCs = potential sources of contamination.

- Sediment: Both the selective removal of tar balls and dredging alternatives considered for the sediment adjacent to the PSC 16 outfall include sampling and laboratory analysis to confirm the boundaries of remediation and the reduction in toxicity. Both alternatives also include removal actions, while selective removal of tar balls involves removal and disposal of tar balls only (the suspected source of toxicity to ecological receptors), dredging would remove the sediment (including embedded tar balls) to a uniform depth.

  Promulgated ARARs for sediment are not available; however, the action level for remediation of sediment at OU 3 by dredging or selective tar ball removal are the exposure endpoints selected for the baseline ERA: chemical concentrations in sediment associated with adverse effects to the survival and growth of aquatic species (measured by toxicity testing) (see Table 2-21).

The estimated costs (capital, operations and maintenance, and total present worth) and cleanup time for each remedial alternative evaluated for storm sewer water, groundwater, and sediment at OU 3 are presented in Table 2-22.

2.9.3 Expected Outcomes of Each Alternative Every remedial alternative in this ROD, excluding the No Action alternative, is designed to achieve ARARs after a designated period of time. In the case of groundwater, even though both Federal and State MCLs can be achieved, aquifer yield conditions are not expected to change such that installation of potable wells in the surficial aquifer becomes economical or efficient. In addition, NADEP operations are not expected to change or cease; therefore, future land use will remain industrial.

2.10 SUMMARY OF THE COMPARATIVE ANALYSES OF ALTERNATIVES. In selecting the preferred alternatives for storm sewer water, groundwater, and sediment at OU 3, nine criteria were used to evaluate the alternatives developed in the feasibility study. The first seven are technical criteria based on the degree of protection of the environment, cost, and engineering feasibility issues. These seven criteria are overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost. The alternatives were further evaluated based on the final two criteria: acceptance by the USEPA and FDEP, and acceptance by the community. The nine criteria are also categorized into three groups:

- *threshold criteria* -- overall protection of human health and the environment and compliance with ARARs,

- *primary balancing criteria* -- long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost; and

- *modifying criteria* -- USEPA and FDEP acceptance and community acceptance.

The USEPA requires that the alternatives implemented must satisfy the threshold criteria. Primary balancing criteria weigh the major tradeoffs among alternatives. Modifying criteria are considered after public comment.

Table 2-21
Key ARARs for Sediment

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
Federal ARARs			
Clean Water Act (CWA), National Permit Discharge Elimination System (NPDES) (40 CFR Part 122 and 125)	Requires permits for discharge of any pollutant into the navigable waters of the United States. Permits specify allowable concentrations of contaminants that may be present in the effluent stream.	Because Naval Air Station Jacksonville is a CERCLA site, only the substantive requirements of attaining a NPDES permit is required for remedial alternatives that involve discharging pollutants to navigable waters.	Action-specific
Endangered Species Act Regulations (50 CFR Parts 81, 225, 402)	The Act requires Federal agencies to take action to avoid jeopardizing the continued existence of federally listed endangered or threatened species.	Endangered or threatened species may be present in the vicinity of OU 3. If a planned remedial action could potentially affect an endangered species, this regulation will apply.	Location-specific
National Environmental Policy Act Wetlands, Floodplains, Important Farmland, Coastal Zones, etc. (40 CFR Part 6)	Appendix A sets forth the policy for carrying out the Floodplains Executive Order 11988. This appendix requires cleanup in a floodplain not be selected unless determination is made that no practicable alternative exists.	If a remedial action will be implemented in a designated floodplain, alternatives should be considered to reduce the risk of flood loss and preserve and restore floodplains.	Location-specific
Resource Conservation and Recovery Act (RCRA) Regulations, Identification and ListIng of Hazardous Wastes (40 CFR Part 261)	Defines listed and characteristic hazardous wastes subject to RCRA. Appendix II contains the Toxicity Characteristic Leaching Procedure.	Based on the history of operations at OU 3 and the solvents used during operations, any investigative-derived waste would be analyzed and classified prior to disposal.	Chemical-specific Action-specific
RCRA Regulations, Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263)	These regulations establish procedures to be followed when transporting manifested hazardous waste within the United States.	If a remedial alternative for OU 3 includes the offslte transportation of hazardous waste for treatment and/or disposal, transporters must meet these requirements.	Action-specific
RCRA Regulations, LDRs (40 CFR Part 268)	This regulation establishes restrictions on land disposal of untreated hazardous wastes and provides standards for treatment of hazardous waste prior to land disposal.	Any investigative-derived wastes generated as a result of remedial actions would be analyzed and characterized prior to disposal. Remedial alternatives that generate a wastestream requiring offslte disposal (e.g., spent carbon filters or exchange resins from treatment of extracted groundwater) will need to achieve the LDRs.	Action-specific

See notes at end of table.

Table 2-21 (Continued)
Key ARARs for Sediment

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
<u>Federal ARARs</u> (Continued)			
RCRA Regulations, LDRs for Contaminated Debris (40 CFR Parts 270 and 271)	Hazardous debris, under these regulations, can be managed so that treated, cleaned debris may be disposed as non-hazardous waste. Treatment residuals containing the original contaminant remain a hazardous waste and must be disposed as such.	If a remedial alternative for OU 3 generates hazardous debris (e.g., if pavement or concrete contaminated with hazardous waste requires removal), these regulations will apply to disposal and/or treatment of that debris.	Action-specific
<u>State ARARs</u>			
Florida Rules on Permits (Chapter 62-4, Florida Administrative Code [FAC])	Provides permitting requirements for water pollution sources and air emissions units.	The regulation will apply to offsite CERCLA activities requiring air emissions or water discharge permits.	Action-specific
Florida Wastewater Facility Permits (Chapter 62-620, FAC)	Establishes requirements for wastewater permits. Because Florida is a designated state (i.e., has the authority to implement the NPDES permits), one permit will suffice to meet both Federal and State discharge requirements.	If a remedial alternatives consists of the discharge of wastewater to navigable waters, the substantive requirements of this rule will need to be achieved.	Action-specific
Hazardous Waste Rules (Chapter 62-730, FAC)	These rules adopt by reference appropriate sections of 40 CFR Parts 260 through 268 and established minor additions and exceptions to these regulations concerning the generation, storage, treatment, transportation, and disposal of hazardous waste.	Based on the history of operations at OU 3 and the solvents used during operations, any investigative-derived waste would be analyzed and classified prior to disposal.	Action-specific
<u>State Guidance Materials</u>			
Approach to the Assessment of Sediment Quality in Florida Coastal Waters	Recommends effects-based sediment quality assessments.	These guidelines will be considered when conducting the ecological risk assessment and in establishing remedial action objectives for sediment at the site.	TBC
Soil Cleanup Goals for Florida	Provides maximum concentration levels of contaminants for soil in the State of Florida. Includes levels for residential, industrial, and leaching exposure scenarios.	The values in this guidance should be considered when determining cleanup levels for soil.	TBC

Notes: CERCLA = Comprehensive Environmental Response, Compensation and Liability Act.
TBC = to be considered.
FDEP = Florida Department of Environmental Protection.
PSCs = potential sources of contamination.
ARARs = applicable or relevant and appropriate requirements.
OU = operable unit.
CFR = Code of Federal Regulations.
LDRs = Land Disposal Restrictions.

Table 2-22
Estimated Costs and Cleanup Times for Remedial Alternatives Evaluated in the FS for OU 3

Record of Decision
PSCs 11, 12, 13, 14 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

	Estimated Cost[1]			
	Capital Costs (Direct + Indirect)	Present Worth of Operations and Maintenance	Total Present Worth Cost	Estimated Cleanup Time
Storm Sewer Water				
No Action	0	$77,100	$84,800	30 years[2]
Cured-In-Place Pipe	$1,843,500	$90,400	$2,127,300	2 months
Groundwater				
Area B:				
No Action	$7,000	$233,300	$264,300	30 years[2]
Enhanced Biodegradation	$166,100	$324,500	$539,700	4 years
Extraction and Treatment	$253,400[3]/ $601,000[4]	$461,900[3]/ $451,800[4]	$786,800[3]/ $1,157,100[4]	5 years
Chemical Oxidation	$340,400	$163,500	$554,300	8 months
Area C:				
No Action	$7,000	$233,300	$264,300	30 years[2]
Enhanced Biodegradation	$264,900	$479,900	$819,300	4 years
Extraction and Treatment	$376,900[3]/ $723,300[4]	$1,250,000[3]/ $1,217,800[4]	$1,789,600[3]/ $2,135,200[4]	20 years
Area D:				
No Action	$7,000	$233,300	$264,300	30 years[2]
Enhanced Biodegradation	$269,100	$600,500	$956,600	4 years
Extraction and Treatment	$386,600[3]/ $733,000[4]	$1,136,600[3]/ $1,107,200[4]	$1,675,400[3]/ $2,024,200[4]	17 years
Area F:				
No Action	$7,000	$233,300	$264,300	30 years[2]
Natural Attenuation	$53,700	$506,200	$615,900	38 years
Air Sparging	$463,700	$469,900	$1,027,000	6 years
Chemical Oxidation	$581,900	$489,300	$1,178,300	5 years
Area G:				
No Action	$7,000	$233,300	$264,300	30 years[2]
Natural Attenuation	$53,700	$509,800	$619,900	39 years
Air Sparging	$329,400	$348,900	$746,100	6 years
Chemical Oxidation	$583,800	$473,100	$1,162,600	5 years
Sediment				
No Action	0		0	NA
Dredging	$274,100	$6,700	$308,900	2 months
Selective Removal of Tar Balls	$65,900	$6,700	$79,900	1 month

[1] Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs of OU 3. Costs are rounded to the nearest $100.

[2] An implementation time of 30 years was used, based on USEPA guidance.

[3] Treatment of extracted groundwater by air stripping.

[4] Treatment of extracted groundwater by ultraviolet light and oxidation.

Notes: NA = not applicable.
OU = operable unit.
FS = feasibility study.
PSC = potential source of contamination.
USEPA = U.S. Environmental Protection Agency.

Using the threshold and primary balancing criteria, the remedial alternatives for OU 3 were evaluated individually and against one another in order to select a preferred remedy.

To aid discussion and comparison, definitions and/or descriptions of the first six criteria are provided here.

Overall Protection of Human Health and the Environment. Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Compliance with Applicable or Relevant and Appropriate Requirements. Section 121(d) of CERCLA and NCP 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a State in a timely manner and that are more stringent than Federal requirements and are consistently enforced may be applicable.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those State standards that are identified by a State in a timely manner and that are more stringent than Federal requirements may be relevant and appropriate.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for invoking a waiver.

Long-term Effectiveness and Permanence. Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Reduction of Toxicity, Mobility, or Volume Through Treatment. Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Short-term Effectiveness. Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community and the environment during construction and operation of the remedy until cleanup levels are achieved.

Implementability. Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

The comparative analyses of the alternatives individually to the criteria for storm sewer water, groundwater (Areas B, C, D, F, and G), and sediment are presented in Tables 2-23 through 2-29. The comparative analyses of the alternatives to each other, by criteria, are presented in the text below.

Storm Sewer Water. Since there are only the No Action and CIPP alternatives and the State of Florida has mandated that FSWS must be attained, no detailed comparative analysis will be done for storm sewer water. The No Action alternative is inferior in every respect to the CIPP alternative. The No Action alternative does not comply with ARARs nor does it provide for the reduction or elimination of the TCE in the storm sewer.

Groundwater Areas B, C, D, F, and G.

Overall Protection of Human Health and the Environment. All of the alternatives, except the No Action alternative, are protective of human health and the environment by eliminating, reducing, or controlling risks posed by the contaminants in the groundwater through treatment of the contaminants and/or institutional controls. The natural attenuation alternative only provides minimum control of the risk for a number of years through the use of institutional controls which restricts groundwater usage. The air sparging, extraction and treatment, enhanced biodegradation, and chemical oxidation alternatives all reduce risks by removal and/or destruction of the contaminants over varying periods of time. These alternatives also provide more active treatment to the groundwater whereas the natural attenuation alternative is a passive treatment process.

The No Action alternative would not be protective of future users of the groundwater since it includes no treatment. Only if land use controls were implemented would there be minimal control of risk.

Compliance with ARARs. Other than the No Action alternative, the alternatives will all meet or comply with the ARARs. Since natural attenuation is a slower process, it will take this alternative much longer (e.g., approximately 38 years) to achieve the chemical-specific ARARs for VOCs in groundwater.

Since the No Action alternative retains the status quo, it would not comply with the chemical-specific ARARs and there are no location-specific or action-specific ARARs associated with no action.

Long-term Effectiveness and Permanence. All the alternatives, except for the No Action alternative, should provide long-term protection or permanent reduction in risk since the VOCs in groundwater will be destroyed through the treatment process. As noted above, the natural attenuation alternative will take much

Table 2-23
Comparative Analysis of Storm Sewer Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives	
	No Action	Cured-In-Place Pipe
Overall Protection of Human Health and the Environment		
Risk Reduction/Control	None	Risk is eliminated
Short-Term or Cross-Media Effects	None	Storm sewer water will no longer be affected by groundwater infiltration
Compliance with ARARs		
Chemical-Specific ARARS	Storm water expected to exceed FSWS	Complete compliance of storm sewer water with FSWS expected
Location-Specific ARARs	No location-specific ARARs	Complies with location-specific ARARs
Action-Specific ARARs	No action-specific ARARs	Complies with action-specific ARARs
Long-Term Effectiveness and Permanence		
Magnitude of Residual Risk	No risks for human or ecological receptors were predicted	No risks for human or ecological receptors were predicted
Adequacy and Reliability of Controls	NA	The design life of CIPP material is reported to be 50 years
Reduction of Toxicity, Mobility, or Volume Through Treatment		
Treatment Process/Remedy Used	None	CIPP
Contaminants Destroyed or Treated	None	None
Reduction of Toxicity, Mobility, or Volume	None	Contaminated storm sewer water will be removed for CIPP installation, and ongoing source will be abated
Irreversibility of Treatment	NA	Remedy not easily reversed due to curing process of CIPP
Type and Quantity of Treatment Residuals	None	Booms will be placed at storm sewer outfall as a precaution against release of the curing resin into the river
Short-Term Effectiveness		
Protection of Community	None	Community fully protected
Protection of Workers	None	Workers entering storm sewer should follow confined space entry procedures
Environmental Effects	No change	No adverse environmental effects
Time until Treatment / O&M is Complete	NA / 30 years[2]	2 months / 5 years
Implementability		
Ability to Construct Technology	NA	Easily implemented
Reliability of Technology	NA	Very reliable

See notes at end of table.

Table 2-23 (Continued)
Comparative Analysis of Storm Sewer Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives	
	No Action	Cured-In-Place Pipe
Ability to Perform Additional Remediation, if Necessary	No implement to performing additional remediation	CIPP could be installed in additional portions of the storm sewer if deemed necessary
Availability of Technology	Storm sewer water monitoring and site reviews easily implemented	Several available vendors to install CIPP
Coordination/Approval with Other Agencies	None	None
Cost[1]		
Capital Cost	$0	$1,843,500
Present Worth Operations and Maintenance Cost	$77,100	$90,400
Total Present Worth of Alternative	$84,800	$2,127,300
State/Support Agency Acceptance	Acceptable to wait and determine if Area F remediation solves problem.	Acceptable (if Area F remediation doesn't control the VOCs in storm sewer)
Community Acceptance	Acceptable to wait and determine if Area F remediation solves problem.	Acceptable (if Area F remediation doesn't control the VOCs in storm sewer)

[1] Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.

[2] An implementation time of 30 years was used, based on U.S. Environmental Protection Agency guidance.

Notes: ARARs = applicable or relevant and appropriate requirements.
FSWS = Florida surface water standards.
NA = not applicable.
O&M = operations and maintenance.
CIPP = cured-in-place pipe.
OU = operable unit.
PSC = potential source of contamination.
VOCs = volatile organic compounds.

Table 2-24
Comparative Analysis of Area B Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives			
	No Action	Enhanced Biodegradation	Extraction and Treatment	Chemical Oxidation
Overall Protection of Human Health and the Environment				
Risk Reduction/Control	Minimum control of risk through groundwater use restrictions	Risks to human receptors reduced	Risks to human receptors reduced	Risks to human receptors reduced
Short-Term or Cross-Media Effects	None	None	None	None
Compliance with ARARs				
Chemical-Specific ARARs	Will not comply with chemical-specific ARARs	Will achieve chemical-specific ARARs for VOCs	Will achieve chemical-specific ARARs for VOCs	Will achieve chemical-specific ARARs for VOCs
Location-Specific ARARs	No location-specific ARARs	Complies with location-specific ARARs	Complies with location-specific ARARs	Complies with location-specific ARARs
Action-Specific ARARs	No action-specific ARARs	Complies with action-specific ARARs	Complies with action-specific ARARs	Complies with action-specific ARARs
Long-Term Effectiveness and Permanence				
Magnitude of Residual Risk	Risks likely to remain for decades	Risk reduced through destruction of VOCs	Risk reduced through destruction of VOCs	Risk reduced through destruction of VOCs
Adequacy and Reliability of Controls	Risks will be controlled only through groundwater use restrictions	Emerging technology. Treatability studies and monitoring will determine adequacy	Proven technology for treatment of VOCs	Emerging technology. Treatability studies and monitoring will determine adequacy
Reduction of Toxicity, Mobility, or Volume Through Treatment				
Treatment Process/Remedy Used	None	Enhancement of natural degradation processes	Groundwater extraction and ex situ treatment	Injection of oxidant to chemically destroy VOCs
Contaminants Destroyed or Treated	None	VOCs in groundwater	VOCs in groundwater	VOCs in groundwater

See notes at end of table.

Table 2-24 (Continued)
Comparative Analysis of Area B Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives			
	No Action	Enhanced Biodegradation	Extraction and Treatment	Chemical Oxidation
Reduction of Toxicity, Mobility, or Volume	Only through on-going natural degradation of VOCs	Reduces toxicity and volume of VOCs. Will not reduce mobility, but significant migration not expected during short treatment duration	Reduces toxicity, mobility, and volume of VOCs in groundwater	Reduces toxicity, mobility, and volume of VOCs in groundwater
Irreversibility of Treatment	NA	Treatment process is irreversible	Treatment process is irreversible	Treatment process is irreversible
Type and Quantity of Treatment Residuals	None	None	Air emissions expected to comply with Florida air emission standards Potential spent packing material for treatment via air stripping will be disposed offsite	
Short-Term Effectiveness				
Protection of Community	None	Community fully protected	Community fully protected	Community fully protected
Protection of Workers	None	Minimum exposure to workers possible during groundwater monitoring activities	Minimum exposure to workers possible during groundwater monitoring activities	Minimum exposure to workers possible during groundwater monitoring activities
Environmental Effects	No change	None	None	None
Time until Treatment / O&M is Complete	NA / 30 years[2]	4 years / 5 years	5 years / 10 years	8 months / 5 years
Implementability				
Ability to Construct Technology	NA	Easily implemented, and no above-ground equipment	Moderate; Coordination required for heavy traffic and numerous utilities at OU 3	Moderate; Coordination required for heavy traffic and numerous utilities at OU 3

See notes at end of table.

Table 2-24 (Continued)
Comparative Analysis of Area B Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives			
	No Action	Enhanced Biodegradation	Extraction and Treatment	Chemical Oxidation
Reliability of Technology	NA	Technology is reliable; treatability studies will indicate proper nutrient dosage and injection point locations	Reliable; treatability studies will provide accurate predictions of O&M requirements and appropriate system design parameters	Reliable; treatability studies will determine appropriate system design parameters
Ability to Perform Additional Remediation, if Necessary	No impediment to performing additional remediation	No impediment to performing additional remediation	No impediment to performing additional remediation	No impediment to performing additional remediation
Availability of Technology	Groundwater monitoring and site review easily implemented	Readily available	Readily available	Readily available
Coordination/Approval with Other Agencies	None	None	Yes, Local and State Agencies	None
Cost[1]				
Capital Cost	$7,000	$166,100	$253,400[3] / $600,100[4]	$340,400
Present Worth Operations and Maintenance Cost	$233,300	$324,500	$461,900[3] / $451,800[4]	$163,500
Total Present Worth of Alternative	$264,300	$539,700	$786,800[3] / $1,157,100[4]	$554,300
State/Support Agency Acceptance	Unacceptable	Acceptable	Acceptable	Acceptable
Community Acceptance	Acceptable	Unacceptable	Unacceptable	Unacceptable

[1] Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.
[2] An implementation time of 30 years was used, based on USEPA guidance.
[3] Cost represents treatment of extracted groundwater via air stripping.
[4] Cost represents treatment of extracted groundwater via untraviolet light/oxidation.

Notes: ARARs = applicable or relevant and appropriate requirements.
O&M = operations and maintenance.
NA = not applicable.
OU = operable unit.
PSC = potential source of contamination.
VOCs = volatile organic compound.
USEPA = U.S. Environmental Protection Agency.

Table 2-25
Comparative Analysis of Area C Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives		
	No Action	Enhanced Biodegradation	Extraction and Treatment
Overall Protection of Human Health and the Environment			
Risk Reduction/Control	Minimum control of risk through groundwater use restrictions	Risks to human receptors reduced	Risks to human receptors reduced
Short-Term or Cross-Media Effects	None	None	None
Compliance with ARARs			
Chemical-Specific ARARS	Will not comply with chemical-specific ARARs	Will achieve chemical-specific ARARs for VOCs	Will achieve chemical-specific ARARs for VOCs
Location-Specific ARARs	No location-specific ARARs	Complies with location-specific ARARs	Complies with location-specific ARARs
Action-Specific ARARs	No action-specific ARARs	Complies with action-specific ARARs	Complies with action-specific ARARs
Long-Term Effectiveness and Permanence			
Magnitude of Residual Risk	Risks likely to remain for decades	Risk reduced through destruction of VOCs	Risk reduced through destruction of VOCs
Adequacy and Reliability of Controls	Risks will be controlled only through groundwater use restrictions	Emerging technology. Treatability studies and monitoring will determine adequacy	Proven technology for treatment of VOCs
Reduction of Toxicity, Mobility, or Volume Through Treatment			
Treatment Process/Remedy Used	None	Enhancement of natural degradation processes	Groundwater extraction and ex situ treatment
Contaminants Destroyed or Treated	None	VOCs in groundwater	VOCs in groundwater
Reduction of Toxicity, Mobility, or Volume	Only through ongoing natural degradation of VOCs	Reduces toxicity and volume of VOCs. Will not reduce mobility, but significant migration not expected during short treatment duration	Reduces toxicity, mobility, and volume of VOCs in groundwater
Irreversibility of Treatment	NA	Treatment process is irreversible	Treatment process is irreversible
Type and Quantity of Treatment Residuals	None	None	Air emissions expected to comply with Florida air emission standards Potential spent packing material for treatment via air stripping will be disposed offsite

See notes at end of table.

Table 2-25 (Continued)
Comparative Analysis of Area C Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives		
	No Action	Enhanced Biodegradation	Extraction and Treatment
Short-Term Effectiveness			
Protection of Community	None	Community fully protected	Community fully protected
Protection of Workers	None	Minimum exposure to workers possible during groundwater monitoring activities	Minimum exposure to workers possible during groundwater monitoring activities
Environmental Effects	No change	None	None
Time until Treatment / O&M is Complete	NA / 30 years[2]	4 years / 5 years	20 years / 25 years
Implementability			
Ability to Construct Technology	NA	Relatively easily implemented; will require coring through thick concrete on taxiway and installation may interfere with flightline activities, but no above-ground equipment is required	Difficult; installation of above-ground equipment and below-grade conveyance piping would be difficult due to taxiway at Area C
Reliability of Technology	NA	Technology is reliable; treatability studies will indicate proper nutrient dosage and injection point locations	Reliable; treatability studies will provide accurate predictions of O&M requirements and appropriate system design parameters
Ability to Perform Additional Remediation, if Necessary	No impediment to performing additional remediation	No impediment to performing additional remediation	No impediment to performing additional remediation
Availability of Technology	Groundwater monitoring and site review easily implemented	Readily available	Readily available
Coordination/Approval with Other Agencies	None	None	Yes, Local and State Agencies
Cost[1]			
Capital Cost	$7,000	$264,900	$376,900[3] / $723,300[4]
Present Worth Operations and Maintenance Cost	$233,300	$479,900	$1,250,000[3] / $1,217,800[4]
Total Present Worth of Alternative	$264,300	$819,300	$1,789,600[3] / $2,135,200[4]
State/Support Agency Acceptance	Unacceptable	Acceptable	Acceptable

See notes at end of table.

Table 2-25 (Continued)
Comparative Analysis of Area C Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives		
	No Action	Enhanced Biodegradation	Extraction and Treatment
Community Acceptance	Unacceptable	Acceptable	Unacceptable

[1] Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.

[2] An implementation time of 30 years was used, based on USEPA guidance.

[3] Cost represents treatment of extracted groundwater via air stripping.

[4] Cost represents treatment of extracted groundwater via untraviolet light/oxidation.

Notes: ARARs = applicable or relevant and appropriate requirements.
O&M = operations and maintenance.
NA = not applicable.
OU = operable unit.
PSC = potential source of contamination.
VOCs = volatile organic compounds.
USEPA = U.S. Environmental Protection Agency.

Table 2-26
Comparative Analysis of Area D Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives		
	No Action	Enhanced Biodegradation	Extraction and Treatment
Overall Protection of Human Health and the Environment			
Risk Reduction/Control	Minimum control of risk through groundwater use restrictions	Risks to human receptors reduced	Risks to human receptors reduced
Short-Term or Cross-Media Effects	None	None	None
Compliance with ARARs			
Chemical-Specific ARARS	Will not comply with chemical-specific ARARs	Will achieve chemical-specific ARARs for VOCs	Will achieve chemical-specific ARARs for VOCs
Location-Specific ARARs	No location-specific ARARs	Complies with location-specific ARARs	Complies with location-specific ARARs
Action-Specific ARARs	No action-specific ARARs	Complies with action-specific ARARs	Complies with action-specific ARARs
Long-Term Effectiveness and Permanence			
Magnitude of Residual Risk	Risks likely to remain for decades	Risk reduced through destruction of VOCs	Risk reduced through destruction of VOCs
Adequacy and Reliability of Controls	Risk will be controlled only through ground-water use restrictions	Emerging technology. Treatability studies and monitoring will determine adequacy	Proven technology for treatment of VOCs
Reduction of Toxicity, Mobility, or Volume Through Treatment			
Treatment Process/Remedy Used	None	Enhancement of natural degradation processes	Groundwater extraction and ex situ treatment
Contaminants Destroyed or Treated	None	VOCs in groundwater	VOCs in groundwater
Reduction of Toxicity, Mobility, or Volume	Only through ongoing natural degradation of VOCs	Reduces toxicity and volume of VOCs. Will not reduce mobility, but significant migration not expected during short treatment duration	Reduces toxicity, mobility, and volume of VOCs in groundwater
Irreversibility of Treatment	NA	Treatment process is irreversible	Treatment process is irreversible
Type and Quantity of Treatment Residuals	None	None	Air emissions expected to comply with Florida air emission standards
			Potential spent packing material for treatment via air stripping will be disposed offsite

See notes at end of table.

Table 2-26 (Continued)
Comparative Analysis of Area D Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives		
	No Action	Enhanced Biodegradation	Extraction and Treatment
Short-Term Effectiveness			
Protection of Community	None	Community fully protected	Community fully protected
Protection of Workers	None	Minimum exposure to workers possible during groundwater monitoring activities	Minimum exposure to workers possible during system installation and groundwater monitoring activities
Environmental Effects	No change	None	None
Time until Treatment / O&M is Complete	NA / 30 years[2]	4 years / 5 years	17 years / 20 years
Implementability			
Ability to Construct Technology	NA	Relatively easily implemented; no above-ground equipment or utilities usage required	Difficult; horizontal drilling for conveyance piping would be required for large Area D plume, which is overlain by a street, buildings and an aircraft maintenance hangar; above-ground equipment required in congested NADEP area
Reliability of Technology	NA	Technology is reliable; treatability studies will indicate proper nutrient dosage and injection point locations	Reliable; treatability studies will provide accurate predictions of O&M requirements and appropriate system design parameters
Ability to Perform Additional Remediation, if Necessary	No impediment to performing additional remediation	No impediment to performing additional remediation	No impediment to performing additional remediation
Availability of Technology	Groundwater moni-toring and site review easily implemented	Readily available	Readily available
Coordination/Approval with Other Agencies	None	None	Yes, Local and State Agencies
Cost[1]			
Capital Cost	$7,000	$269,100	$386,600[3] / $733,000[4]
Present Worth Operations and Maintenance Cost	$233,300	$600,500	$1,136,600[3] / $1,107,200[4]
Total Present Worth of Alternative	$264,300	$956,600	$1,675,400[3] / 2,024,200[4]
State/Support Agency Acceptance	Unacceptable	Acceptable	Acceptable

See notes at end of table.

Table 2-26 (Continued)
Comparative Analysis of Area D Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives		
	No Action	Enhanced Biodegradation	Extraction and Treatment
Community Acceptance	Acceptable	Acceptable	Unacceptable

[1] Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.

[2] An implementation time of 30 years was used, based on USEPA guidance.

[3] Cost represents treatment of extracted groundwater via air stripping.

[4] Cost represents treatment of extracted groundwater via ultraviolet light/oxidation.

Notes: ARARs = applicable or relevant and appropriate requirements.

O&M = operations and maintenance.

NA = not applicable.

OU = operable unit.

PSC = potential source of contamination.

VOCs = volatile organic compounds.

NADEP = Naval Aviation Depot.

USEPA = U.S. Environmental Protection Agency.

Table 2-27
Comparative Analysis of Area F Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives			
	No Action	Natural Attenuation	Air Sparging	Chemical Oxidation
Overall Protection of Human Health and the Environment				
Risk Reduction/Control	Minimum control of risk through groundwater use restrictions	Minimum control of risk through groundwater use restrictions	Risks to human receptors reduced	Risks to human receptors reduced
Short-Term or Cross-Media Effects	None	None	None	None
Compliance with ARARs				
Chemical-Specific ARARS	Will not comply with chemical-specific ARARs	Will achieve chemical-specific ARARs for VOCs in the long-term (38 years)	Will achieve chemical-specific ARARs for VOCs	Will achieve chemical-specific ARARs for VOCs
Location-Specific ARARs	No location-specific ARARs	Complies with location-specific ARARs	Complies with location-specific ARARs	Complies with location-specific ARARs
Action-Specific ARARs	No action-specific ARARs	Complies with action-specific ARARs	Complies with action-specific ARARs	Complies with action-specific ARARs
Long-Term Effectiveness and Permanence				
Magnitude of Residual Risk	Risks likely to remain for decades	Risk likely to remain for decades	Risk reduced through destruction of VOCs	Risk reduced through destruction of VOCs
Adequacy and Reliability of Controls	Risk will be controlled only through groundwater use restrictions	Risk will be controlled only through groundwater use restrictions	Proven technology for treatment of VOCs	Emerging technology. Treatability studies and monitoring will determine adequacy
Reduction of Toxicity, Mobility, or Volume Through Treatment				
Treatment Process/Remedy Used	None	Natural biological, physical, and chemical processes	Air sparging to enhance volatilization of VOCs	Injection of oxidant to chemically destroy VOCs
Contaminants Destroyed or Treated	None	None	VOCs in groundwater	VOCs in groundwater

See notes at end of table.

Table 2-27 (Continued)
Comparative Analysis of Area F Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives			
	No Action	Natural Attenuation	Air Sparging	Chemical Oxidation
Reduction of Toxicity, Mobility, or Volume	Only through on-going natural degradation of VOCs	Only through on-going natural degradation of VOCs	Reduces toxicity, and volume of VOCs in ground-water; mobility controlled through soil vapor extraction	Reduces toxicity, mobility, and vol-ume of VOCs in groundwater
Irreversibility of Treatment	NA	Natural attenuation process is irreversible	Treatment pro-cess is irrevers-ible	Treatment process is irreversible
Type and Quantity of Treatment Residuals	None	None	Spent granular activated carbon from soil vapor extraction will be transported offsite for regeneration or disposal	Used bag filters will be disposed offsite
Short-Term Effectiveness				
Protection of Community	None	Community fully protected	Community fully protected	Community fully protected
Protection of Workers	None	Minimum exposure to workers possible during groundwater monitoring activ-ities	Minimum expo-sure to workers possible during system installa-tion, O&M, and groundwater monitoring activ-ities	Minimum expo-sure to workers possible during system installation and groundwater monitoring activities
Environmental Effects	No change	No change	None	None
Time until Treatment / O&M is Complete	NA / 30 years[2]	38 years / 38 years	6 years / 10 years	5 years / 10 years
Implementability				
Ability to Construct Technology	NA	Monitoring well installation and monitoring easily implemented	Moderate; Coor-dination required for heavy traffic and numerous utilities at OU 3	Moderate; Coor-dination required for heavy traffic and numerous utilities at OU 3

See notes at end of table.

Table 2-27 (Continued)
Comparative Analysis of Area F Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives			
	No Action	Natural Attenuation	Air Sparging	Chemical Oxidation
Reliability of Technology	NA	Ongoing degradation processes suggest natural attenuation is reliable for reduction of VOCs in the shallow surficial aquifer at OU 3	Reliable; treatability studies will provide accurate predictions of O&M requirements and appropriate system design parameters	Reliable; treatability studies will provide accurate predictions of O&M requirements and appropriate system design parameters
Ability to Perform Additional Remediation, if Necessary	No impediment to performing additional remediation	No impediment to performing additional remediation	No impediment to performing additional remediation	No impediment to performing additional remediation
Availability of Technology	Groundwater monitoring and site review easily implemented	Groundwater monitoring and site review easily implemented	Readily available	Readily available
Coordination/Approval with Other Agencies	None	None	Yes, Local and State Agencies	None
Cost[1]				
Capital Cost	$7,000	$53,700	$463,700	$581,900
Present Worth Operations and Maintenance Cost	$233,300	$506,200	$469,900	$489,300
Total Present Worth of Alternative	$264,300	$615,900	$1,027,000	$1,178,300
State/Support Agency Acceptance	Unacceptable	Acceptable	Acceptable	Acceptable
Community Acceptance	Unacceptable	Unacceptable	Unacceptable	Acceptable

[1] Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.

[2] An implementation time of 30 years was used, based on USEPA guidance.

Notes: ARARs = applicable or relevant and appropriate requirements.
O&M = operations and maintenance.
NA = not applicable.
OU = operable unit.
PSC = potential source of contamination.
VOCs = volatile organic compounds.
USEPA = U.S. Environmental Protection Agency.

Table 2-28
Comparative Analysis of Area G Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives			
	No Action	Natural Attenuation	Air Sparging	Chemical Oxidation
Overall Protection of Human Health and the Environment				
Risk-Reduction/Control	Minimum control of risk through groundwater use restrictions	Minimum control of risk through groundwater use restrictions	Risks to human reception reduced	Risks to human receptors reduced
Short-Term or Cross-Media Effects	None	None	None	None
Compliance with ARARs				
Chemical-Specific ARARS	Will not comply with chemical-specific ARARs	Will achieve chemical-specific ARARs for VOCs in the long-term (39 years)	Will achieve chemical-specific ARARs for VOCs	Will achieve chemical-specific ARARs for VOCs
Location-Specific ARARs	No location-specific ARARs	Complies with location-specific ARARs	Complies with location-specific ARARs	Complies with location-specific ARARs
Action-Specific ARARs	No action-specific ARARs	Complies with action-specific ARARs	Complies with action-specific ARARs	Complies with location-specific ARARs
Long-Term Effectiveness and Permanence				
Magnitude of Residual Risk	Risks likely to remain for decades	Risks likely to remain for de-cades	Risk reduced through destruction of VOCs	Risk reduced through destruction of VOCs
Adequacy and Reliability of Controls	Risk will be controlled only through groundwater use restrictions	Risk will be con-trolled only through ground-water use restrictions	Proven technology for treatment of VOCs	Emerging technology. Treatability studies and monitoring will determine adequacy
Reduction of Toxicity, Mobility, or Volume Through Treatment				
Treatment Process/Remedy Used	None	Natural biological, physical, and chemical processes	Air sparging to enhance volatilization of VOCs	Injection of oxidant to chemically de-stroy VOCs
Contaminants Destroyed or Treated	None	None	VOCs in groundwater	VOCs in groundwater
Reduction of Toxicity, Mobility, or Volume	Only through on-going natural degradation of VOCs	Only through on-going natural degradation of VOCs	Reduces toxicity, and volume of VOCs in ground-water; mobility not contained	Reduces toxicity, mobility, and volume of VOCs in groundwater

See notes at end of table

Table 2-28 (Continued)
Comparative Analysis of Area G Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives			
	No Action	Natural Attenuation	Air Sparging	Chemical Oxidation
Irreversibility of Treatment	NA	Natural attenuation process is irreversible	Treatment process is irreversible	Treatment process is irreversible
Type and Quantity of Treatment Residuals	None	None	None	Used bag filters will be disposed offsite
Short-Term Effectiveness				
Protection of Community	None	Community fully protected	Community fully protected	Community fully protected
Protection of Workers	None	Minimum exposure to workers possible during groundwater monitoring activities	Minimum exposure to workers possible during system installation, O&M, and groundwater monitoring activities	Minimum exposure to workers possible during system installation and groundwater monitoring activities
Environmental Effects	No change	No change	None	None
Time until Treatment / O&M is Complete	NA / 30 years[2]	39 years / 39 years	6 years / 10 years	5 years / 10 years
Implementability				
Ability to Construct Technology	NA	Monitoring well installation and monitoring easily implemented	Moderate; Coordination required for heavy traffic and numerous utilities at OU 3	Moderate; Coordination required for heavy traffic and numerous utilities at OU 3
Reliability of Technology	NA	Ongoing degradation processes suggest natural attenuation is reliable for reduction of VOCs in the shallow surficial aquifer at OU 3	Reliable; treatability studies will provide accurate predictions of O&M requirements and appropriate system design parameters	Reliable; treatability studies will provide accurate predictions of O&M requirements and appropriate system design parameters
Ability to Perform Additional Remediation, if Necessary	No impediment to performing additional remediation	No impediment to performing additional remediation	No impediment to performing additional remediation	No impediment to performing additional remediation
Availability of Technology	Groundwater monitoring and site review easily implemented	Groundwater monitoring and site review easily implemented	Readily available	Readily available
Coordination/Approval with Other Agencies	None	None	Yes, Local and State Agencies	None

See notes at end of table

Table 2-28 (Continued)
Comparative Analysis of Area G Groundwater Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives			
	No Action	Natural Attenuation	Air Sparging	Chemical Oxidation
Cost[1]				
Capital Cost	$7,000	$53,700	$329,400	$583,800
Present Worth Operations and Maintenance Cost	$233,300	$509,800	$348,900	$473,100
Total Present Worth of Alternative	$264,300	$619,900	$746,100	$1,162,600
State/Support Agency Acceptance	Unacceptable	Acceptable	Acceptable	Acceptable
Community Acceptance	Unacceptable	Acceptable	Unacceptable	Unacceptable

[1] Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.

[2] An implementation time of 30 years was used, based on USEPA guidance.

Notes: ARARs = applicable or relevant and appropriate requirements.
O&M = operations and maintenance.
NA = not applicable.
OU = operable unit.
PSC = potential source of contamination.
VOCs = volatile organic compounds.
USEPA = U.S. Environmental Protection Agency.

Table 2-29
Comparative Analysis of Sediment Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives		
	No Action	Selective Tar Ball Removal	Dredging
Overall Protection of Human Health and the Environment			
Risk Reduction/Control	None	Risks to ecological receptors reduced	Risks to ecological receptors reduced
Short-Term or Cross-Media Effects	None	None expected	Potential resuspension of sediment during dredging
Compliance with ARARs			
Chemical-Specific ARARS	Will not comply with chemical-specific ARARs	Expected to comply with chemical-specific ARARs	Will comply with chemical-specific ARARs
Location-Specific ARARs	No location-specific ARARs	Complies with location-specific ARARs	Complies with location-specific ARARs
Action-Specific ARARs	No action-specific ARARs	Complies with action-specific ARARs	Complies with action-specific ARARs
Long-Term Effectiveness and Permanence			
Magnitude of Residual Risk	Existing risk will remain	Residual risk may remain if contaminants are not contained entirely within tar balls	Risks to ecological receptors eliminated
Adequacy and Reliability of Controls	NA	Removal technology and disposal method reliable, but potential exists for upgradient sources to recontaminate sediment over time	Removal technology and disposal method reliable, but potential exists for upgradient sources to recon-taminate sediment over time
Reduction of Toxicity, Mobility, or Volume Through Treatment			
Treatment Process/Remedy Used	None	Manual tar ball removal by raking	Dredging
Contaminants Destroyed or Treated	None	PAHs and lead	PAHs and lead
Reduction of Toxicity, Mobility, or Volume	None	Contaminants will be removed from sediment and disposed at an offsite landfill	Contaminants will be removed from sediment and disposed at an offsite landfill
Irreversibility of Treatment	NA	Upgradient sources in St. Johns River could recontaminate sediment over time	Upgradient sources in St. Johns River could recontaminate sediment over time
Type and Quantity of Treatment Residuals	None	None	None

See notes at end of table

Table 2-29 (Continued)
Comparative Analysis of Sediment Alternatives for OU 3

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Criteria	Alternatives		
	No Action	Selective Tar Ball Removal	Dredging
Short-Term Effectiveness			
Protection of Community	None	Community fully protected	Community fully protected
Protection of Workers	None	No known risks for workers exposed to surface water during remediation	No known risks for workers exposed to surface water during implementation
Environmental Effects	No change	Raking will temporarily disturb aquatic receptors, but repopulation is expected to occur quickly after remediation	Dredging will destroy aqat-ic receptors but eventual repopulation is expected
Time until Treatment / O&M is Complete	NA	1 month / NA	2 months / NA
Implementability			
Ability to Construct Technology	NA	Easily implemented	Easily implemented
Reliability of Technology	NA	Expected to be reliable if contaminants contained entirely within tar balls	Very reliable
Ability to Perform Additional Remediation, if Necessary	No impediment to performing additional remediation	No impediment to performing additional remediation	No impediment to perform-ing additional remediation
Availability of Technology	NA	Readily available	Readily available
Coordination/Approval with Other Agencies	None	None	Yes, Local, State, and Federal Agencies
Cost[1]			
Capital Cost	$0	$65,900	$274,100
Present Worth Operations and Maintenance Cost	$0	$6,700	$6,700
Total Present Worth of Alternative	$0	$79,900	$308,900
State/Support Agency Acceptance	Unacceptable	Acceptable	Acceptable
Community Acceptance	Unacceptable	Acceptable	Unacceptable

[1] Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU3. Costs are rounded to the nearest $100.

[2] An implementation time of 30 years was used, based on USEPA guidance.

Notes: ARARs = applicable or relevant and appropriate requirements.
O&M = operations and maintenance.
NA = not applicable.
OU = operable unit.
PSC = potential source of contamination.
PAHs = polycyclic aromatic hydrocarbons.
USEPA = U.S. Environmental Protection Agency.

longer than the other four alternatives to permanently reduce the risk through the VOC destruction process. The air sparging and extraction and treatment processes are proven technologies that have been used for VOC treatment for numbers of years. The enhanced biodegradation and chemical oxidation processes are emerging technologies which will require treatability studies to confirm the destruction capability of these processes. Since the VOCs would be destroyed, there should be no residual risks remaining following remediation. During the time required for natural attenuation to provide permanent protection, land use controls that restrict groundwater usage will be implemented.

The risks associated with the VOCs in the groundwater will remain for decades under the No Action alternative.

Reduction in Toxicity, Mobility, or Volume. The extraction and treatment and chemical oxidation alternatives will bring about a reduction in toxicity, mobility, and volume of the contaminants in the groundwater. Only the toxicity and volume of contaminants would be reduced by the natural attenuation, air sparging, and enhanced biodegradation alternatives. Mobility would not be curtailed or controlled by these three alternatives. The enhanced biodegradation and chemical oxidation alternatives would provide for the greatest reduction in toxicity and volume over the shortest period of time (approximately 4 to 5 years). There should be limited potential for recontamination of groundwater from any of these alternatives although the greatest chance is with natural attenuation and air sparging.

Because there is no treatment associated with the No Action alternative, there will be no reduction in the toxicity, mobility, or volume of the contaminants for decades. Any reduction in toxicity or volume would only occur as natural degradation of the VOCs takes place.

Short-term Effectiveness. Destruction of the VOCs in groundwater would be most rapid with the enhanced biodegradation and chemical oxidation alternatives. Timeframes for the complete destruction to occur is estimated at 4 years and 5 years, respectively. Air sparging is estimated to take 6 to 12 years to volatilize and remove the contaminants from the groundwater while the extraction and treatment alternative will take 17 to 20 years. As has been noted previously, natural attenuation will take the longest to clean up the groundwater, approximately 38 years.

The No Action alternative would not be an effective alternative because future risks to someone drinking the groundwater would still exist. Since no treatment would be initiated, the risk would remain for decades. Also, the potential for other groundwater to become contaminated would not be diminished.

During implementation of these alternatives, the surrounding community and NADEP personnel should continue to be protected from the contaminants in the groundwater and persons installing or operating these systems should have only minimal exposure during the installation or monitoring activities.

Air emissions from the extraction and treatment process would be addressed by engineering controls to make sure the emissions meet applicable Federal and State air emission standards.

Implementability. The technologies and the vendors to construct or implement the technologies are all readily available. Even though enhanced biodegradation and chemical oxidation are emerging technologies, they have been used several times for similar groundwater remediation projects. The natural attenuation, enhanced biodegradation, and chemical oxidation alternatives should be easy to install since there is no need for above ground structures. For natural attenuation additional monitoring wells would be all that is required to implement this alternative.

Because the extraction and treatment alternative requires substantial above ground support facilities (i.e., treatment process equipment), this alternative would be the most difficult to implement and operate. The extraction and treatment system requires close operational controls to make sure the treatment process is working correctly. The air sparging alternative also requires above ground structures (e.g., blowers) for its operation. Besides being moderately difficult to install, it has another limitation. It is necessary to have an unsaturated zone above the groundwater in order to remove the VOCs. Thus, air sparging would not work for removing contaminants from the intermediate layer (below the upper clay) at NAS Jacksonville.

Land use controls to restrict the use of groundwater until it was treated to drinking water standards would be required for all the alternatives. Implementation of these controls should not be difficult since the MOA between the Navy, USEPA, and FDEP is in place at NAS Jacksonville.

Because the groundwater treatment systems would be used in areas where there is a lot of aircraft or ground vehicle movement, close coordination would be required with NADEP prior to and during any installation activities.

Cost. The estimated present worth costs for the alternatives, not including the No Action alternative, ranges from $539,700 for enhanced biodegradation to $2,024,300 for the extraction and treatment alternative. The cost summaries for each alternative considered for each area can be found on Table 2-22.

Federal and State Agency Support. The USEPA and FDEP do not support the use of the No Action alternative because it does not use any type of treatment or provide for a permanent solution. The agencies have expressed their support for all of the other alternatives.

<u>Sediment</u>

Overall Protection of Human Health and the Environment. Both the selective tar ball removal and dredging alternatives will reduce the risks to the ecological receptors. There is a greater potential for re-suspension of contaminated sediment during dredging than there is with the raking operation during the tar ball removal process. The risks to aquatic receptors would remain under the No Action alternative.

Compliance with Applicable or Relevant and Appropriate Requirements. Both the tar ball removal and dredging alternatives are expected to comply with ARARs. The No Action alternative would not comply with the chemical-specific ARARs since the contaminants would remain in place.

Long-term Effectiveness and Permanence. Each alternative, except the No Action alternative, provides some degree of long-term protection. There is the potential that residual risk may remain under the selective tar ball removal alternative if the contamination is not totally contained within the tar balls. This would not be the case with the dredging alternative since the surrounding sediment would be removed along with the tar balls. Likewise, the effectiveness and permanence of these two alternatives are dependent on the possibility that upgradient sources could re-contaminate the remaining sediment over time.

Reduction in Toxicity, Mobility, or Volume. In both the selective tar ball removal and dredging alternatives, the contaminants contained within the tar balls will be removed and taken to an approved off-site location for treatment and/or disposal. Therefore, there will be a reduction in toxicity, mobility and volume of contaminants at PSC 16. Under the No Action alternative there would be no reduction in toxicity, mobility, or volume since there would be no removal or treatment of the contaminants.

Short-term Effectiveness. Both removal alternatives would be accomplished in a short period of time. It would take approximately twice as long (2 months) for the dredging operations than it would for the tar ball removal (1 month). There should be no risk for the worker or surrounding community in either of the alternatives. Raking of the tar balls will temporarily disturb the aquatic receptors and the habitat whereas the dredging operations will destroy the habitat and the associated aquatic receptors. In both cases it is expected that re-population will occur; however, it will take longer under the dredging alternative.

Implementability. It should be relatively easy to implement either the tar ball removal or dredging alternatives. There are contractors in the area who are trained to do these operations. The site logistics of implementation increases with the dredging alternative since storage and handling of the dredge spoil must be addressed rather than just the tar balls. However, logistical considerations would be addressed during the design of the site remedy.

Coordination with local, State, and Federal agencies would be required. However, the amount of coordination would be greater with the dredging alternative than with the selected tar ball removal alternative.

Cost. The estimated cost is almost four times greater for dredging ($308,900) than for tar ball removal ($79,900). Cost summaries can be found in Table 2-22.

Federal and State Agency Support. The USEPA and FDEP do not support the use of the No Action alternative because it does not use any type of treatment or provide for a permanent solution. The agencies have expressed their support for the other two alternatives.

2.11 PRINCIPAL THREAT WASTES. Principal threat wastes are determined by reasonably anticipated future land use as well as the toxicity and mobility characteristics of the source materials that combine to pose a potential risk. The “principal threat” concept is applied to the characterization of “source materials” at a Superfund site. Contaminated groundwater by itself is generally not considered to be a source material, however nonaqueous phase liquids (NAPLs) in groundwater may be viewed as source material. Furthermore, a principal threat source would be one with toxicity and mobility characteristics that would pose a potential risk several orders of magnitude greater than the risk level that is acceptable for current or reasonably expected future land use. Therefore, since the groundwater plumes at most of the Areas of contamination at OU 3 do not have identified source areas, they also do not pose a principal threat. At two of the areas, PSC 48 and Building 780, there is presumed to be non-mobile residual dense nonaqueous-phase liquid (DNAPL) within the aquifer solids. These residual DNAPLs could constitute “source materials” and be considered “principal threats” if the reasonably anticipated future land use were to allow a realistic exposure scenario. However, since neither current nor future reasonably expected land use poses an unacceptable risk, given realistic exposure scenarios, there are no principal threat wastes at OU 3.

2.12 SELECTED REMEDIES. The selected remedies for cleanup of contaminated media at OU 3 are those alternatives that most closely satisfy the balancing and modifying criteria when compared to the other technologies under consideration.

2.12.1 Selected Remedies for Storm Sewer Water; Groundwater Areas B, C, D, F, and G; and PSC 16 Sediment Based on the results of this analysis, which is detailed in the RI/FS for OU 3, the following alternatives for OU 3 storm sewer water, groundwater (Areas B, C, D, F, and G), and sediment were selected as the preferred alternatives by the USEPA, FDEP, and the Navy. During the remedial design and construction phases of remedy implementation, specific elements of the remedy may be changed somewhat from their description herein and in the OU 3 FS. For example, representative technologies for each technology type were selected for detailed evaluation in the FS (e.g., potassium permanganate was the oxidant evaluated for the chemical oxidation alternative). Emerging technologies are continually introduced; if a new technology uses the same operating principles and achieves the same objectives as the technology selected, it could be considered for implementation during the remedial design.

Storm Sewer Water The following course of action has been selected as the preferred remedial alternative for the storm sewer water at OU 3.

- Collect samples of water in the storm sewers within the zone of tidal influence and analyze for VOCs after completion of the remedial activities at groundwater Area F. If the concentrations of VOCs are below the Florida Surface Water Standards, no further action is required for the storm sewer water. If the concentrations of the VOCs exceed Florida Surface Water Standards, installation of CIPP will be the selected remedial alternative for the storm sewer water.

Summary of the Rationale for the Selected Remedy. The likely source of TCE at concentrations above the FSWS in the storm sewer water is infiltrating groundwater. The elevated concentrations of TCE have been detected in a portion of the storm sewers near groundwater hot spot Area F. Therefore, once the Area F groundwater has been treated by its selected remedial alternative, it is expected that TCE may no longer exceed the State criteria in the storm sewer water.

Description of the Selected Remedy. The first component of the selected alternative for the OU 3 storm sewer water is collection of samples from the storm sewers after completion of remedial activities at Area F. The results of this sampling will indicate whether or not remediation of the Area F groundwater has reduced the VOCs detected in the storm sewers, by treating an assumed source of chemicals in the storm sewer water (i.e., infiltration of groundwater from Area F). The storm sewer water samples would be collected from manholes along the storm sewer pipes discharging at the PSC 16 outfall, at locations downgradient of the tidal extent line (refer to Figure 2-17). The samples would be submitted for laboratory analysis for VOCs, and the results compared to the FSWS. If VOCs in the storm sewer water continue to exceed the State criteria, CIPP should be installed in the storm sewers.

If it is necessary, CIPP will be installed to abate the probable source of contamination in the storm sewers (i.e., infiltrating groundwater). This technology does not actively treat VOC contamination present in the storm sewers. A video inspection of the storm sewers verified that groundwater is infiltrating the sewer pipes through leaking joints and cracks. If treatment of the Area F groundwater does not reduce VOCs in the storm sewers to concentrations below State criteria, CIPP will control the infiltration of groundwater. The storm sewer pipes will be dewatered and pressure-washed prior to installation of the CIPP. It is expected that this alternative will achieve the FSWS for TCE once the contaminated water in the storm sewer is removed for CIPP installation, and any remaining contamination is naturally volatilized or diluted by fluctuating tide water within the sewer.

Installation of CIPP includes placing felt tubing saturated with a thermosetting resin into the leaking or damaged section of host pipe through manholes. Heated water is circulated in the tubing to cure the CIPP to the inner walls of the host pipe, forming a continuous impermeable barrier. Any lateral connections to the main pipeline are restored using a remote-controlled cutter, and joints between lateral lines and the main pipe may be grouted, if necessary. It is estimated that up to 2,000 linear feet of CIPP will be used to line the storm sewers in the vicinity of Areas F and G (i.e., an approximately 1,000-foot length in each of the 60-inch diameter sewer pipes).

Samples of the water in the storm sewers within the zone of tidal influence will be collected for VOC analysis after completion of the CIPP installation. The sampling results will be used to evaluate the effectiveness of the infiltration control technology. Scheduled monitoring will be continued until the VOC concentrations in the storm sewer comply with the FSWS. The presumed sampling frequency and number of samples for the storm sewer water monitoring is as follows: samples will be collected from four manholes during each sampling event (one at the upper limit of tidal influence, one at the downgradient boundary of the relined sewer pipe section, and two within the relined section); one quality control sample will be collected during each sampling event; sampling events will occur every 2 months after remediation until the VOCs are below Florida Surface Water Standards for two consecutive sampling events.

Five-year site reviews will be performed to summarize the results of the storm sewer monitoring, evaluate compliance with FSWS in the portion of storm sewers within the zone of tidal influence, and assess the effectiveness of the remedy.

Summary of the Estimated Remedy Costs. The estimated cost of the selected storm sewer alternative will depend on whether the installation of CIPP is deemed necessary after the completion of groundwater remediation at Area F. If the remedial activities at Area F reduce the VOC concentrations in groundwater (the suspected source of chemicals in the storm sewer water) the only cost associated with cleanup of the storm sewers is the confirmatory storm sewer water sampling. If storm sewer water samples are collected from four manholes during two sampling events, approximately 2 months apart, and the results confirm that remediation of Area F has eliminated the VOCs in the storm sewer, the additional cost will be covered by the contingency in the Area F estimate.

If the VOC concentrations in the storm sewer water remain above FSWS after remediation of Area F groundwater has been completed, CIPP will be installed and the estimated present worth cost for the storm sewer remedy will be $2,127,300. The present worth cost is summarized in Table 2-30. The cost estimate includes site preparation, isolating and cleaning a section of the storm sewers, removal and disposal of sediment and water, installation of CIPP, and associated indirect costs. Operation and maintenance (O&M) costs associated with this alternative include monitoring of the water in the storm sewers for a duration of 5 years, and one five-year site review.

The estimated costs for the storm sewer remedy may be refined as a result of remedy changes made during the design and construction phases. The estimated costs presented in Table 2-30 are expected to be within +50 to -30 percent of the actual project cost.

Expected Outcomes of the Selected Remedy. Whether as a result of Area F groundwater remediation or installation of CIPP, the storm sewer remedy will comply with ARARs (FSWS) and eliminate the potential for migration of the contaminated groundwater to the St. Johns River, via the storm sewers. Although TCE has been detected in the storm sewer water at concentrations exceeding the FSWS (maximum of 170 Fg/R versus the 80.7 Fg/R standard) (Table 2-18), unacceptable risks to human health or the environment were not predicted based on exposure to VOCs in the storm sewer water. Elimination of the VOCs in the storm sewer water will ensure continued protection of human and ecological receptors.

<u>Groundwater</u>

<u>Areas C and D</u>. Enhanced biodegradation was selected as the preferred remedial alternative for groundwater Areas C and D. Because the same remedy was selected for the two hot spot areas, the following paragraphs will discuss enhanced biodegradation as it applies to both areas, noting elements of the alternative that are specific to a particular area (e.g., cost).

Summary of the Rationale for the Selected Remedy. The enhanced biodegradation alternative at Areas C and D is a relatively low cost alternative with a short implementation time (4 years for remediation, 5 years O&M). In addition, enhanced biodegradation produces no treatment residuals or utilities maintenance. Enhanced biodegradation can be adapted to various plume sizes and shapes, such as the disconnected plume at Area C and the large, elongated plume at Area D. This alternative would not require a large network of underground piping (such as that required by extraction and treatment), or any above ground equipment, both of which would be difficult in the taxiway (Area C) and the airplane maintenance hangars (Area D).

Description of the Selected Remedy. The enhanced biodegradation alternative will be achieved by enhancing natural bacterial biodegradation of organic contaminants in the groundwater. This is accomplished by introducing nutrients to stimulate

Table 2-30
Cost Summary Table for CIPP Alternative for Storm Water Sewer Water

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Others Areas
of Elevated Groundwater Contamination, Operation Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Cost Item	Cost
DIRECT COSTS	
Site Preparation	$28,400
Remedial Activities	
Isolating/cleaning storm sewer section to be lined	$91,700
Analysis/disposal of water and sediment removed from sewer	$45,400
Installation of CIPP	$1,200,000
Total Direct Cost	$1,365,500
INDIRECT COSTS	
Health and Safety (5% of Total Direct Cost)	$68,300
Administrative and Permitting (5% of Total Direct Cost)	$68,300
Engineering and Design (10% of Total Direct Cost)	$136,600
Construction Support Services (15% of Total Direct Cost)	$204,800
Total indirect cost	$478,000
Total Capital Cost (Direct + Indirect)	$1,843,500
OPERATION AND MAINTENANCE (O&M) COSTS	
ADMINISTRATIVE O&M	
Present Worth - Storm sewer water monitoring (bi-monthly 1 yr, annually 5 yrs)	$70,100
Present Worth - 5-year site reviews (Discount rate of 6%, 5 years)	$20,300
Total O&M Cost (Present worth, Discount rate of 6%, 5 yrs)	$90,400
Total capital and O&M Cost	$1,933,900
Contingency (10% of Total Capital and O&M Cost	$193,400
Total cost of CIPP Alternative for Storm Sewers	$2,127,300

Notes: 1) Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.

2) Cured-in-place pipe will not be installed in the storm sewers if sampling confirms that VOC concentrations are below the Florida Surface Water Standard after remediation of the Area F groundwater is completed.

CIPP = cured-in-place pipe.
PSCs = potential sources of contamination.
OU = operable unit.
VOC = volatile organic compound.
% = percent.
yr = year.

bacterial growth and speed up natural biodegradation of organic compounds. The groundwater contamination at Areas C and D lies within the intermediate zone of the shallow aquifer, which is under anaerobic conditions.

For the purpose of developing the enhanced biodegradation alternative, it was assumed that lactic acid (from HRC™) is the carbon source that will be used to enhance the rate of ***in situ*** anaerobic biodegradation of chlorinated compounds in the groundwater plumes. The HRC™ compound is a polylactate ester that has the consistency of thick paste which can be grouted into small diameter boreholes. Hydration of HRC™ injected into an aquifer triggers the release of lactic acid. The lactic acid produced by HRC™ is metabolized by indigenous anaerobic bacteria to produce hydrogen. The resulting hydrogen can be used by reductive dehalogenators to dechlorinate chlorinated hydrocarbons.

HRC™ will be injected into the groundwater via small diameter boreholes advanced by hollow-stem auger or DPT methods or injected through groundwater monitoring wells. It is assumed that DPT will be used to create boreholes for the injection of HRC™. An HRC™ pump will be used to inject the compound down the borehole. HRC™ will be injected into the plume area through injection points arranged either in a grid pattern or in lines that transect the plume (hereon referred to as barrier rows). The compound is injected the full depth of the contaminated saturated zone. Contaminated groundwater at Areas C and D lies beneath the confining clay layer which extends to approximately 30 feet below land surface (bls). For each area, it is assumed that HRC™ will be injected from 30 to 50 feet bls. Injection at the source area is estimated to require two applications (reinjection 2 years after initial application).

The HRC™ injection point locations required for implementing this alternative at Areas C and D was estimated using a proprietary modeling software provided by the HRC™ vendor. Due to the separated nature of the groundwater plume at Area C and the large size and elongated shape of the plume at Area D, both areas were modeled as having a distinct upgradient and downgradient plume area. HRC™ usage is based upon the following assumptions:

- the initial dosage of HRC™ will be effective for 2 years, after which half the initial amount of HRC™ will be reinjected (the need for HRC™ reinjection will be determined by the results of quarterly groundwater monitoring). It was assumed that the second HRC™ dosage will also last 2 years, for a total treatment duration of 4 years at Areas C and D

Area C:

- maximum concentration of TCE in the upgradient plume area is 2,800 Fg/R; maximum concentrations of TCE in the downgradient plume area is 5,000 Fg/R

- HRC™ will be injected in three barrier rows with 15, 13, and 11 injection points, in the upgradient p1rume area, for a total of 39 boreholes. It was assumed that half the initial amount of HRC™ will be reinjected through 20 points (half the initial number of injection points) in the upgradient plume area, 2 years following the initial injection

- HRC™ will be injected in a barrier row of five injection points in the downgradient plume area; half the initial amount of HRC™ will be reinjected through 5 points in the downgradient plume area, 2 years following the initial injection. (Modeling for Area C indicated three barrier rows with 1-inch diameter boreholes in the downgradient plume; however, this would place one row east of the seawall, in the St. Johns River. Due to problems with implementation, it was assumed that one row of 2-inch diameter boreholes will be used in lieu of three barrier rows).

- 1-inch boreholes will be used for the HRC™ injection points in the upgradient plume area, and 2-inch boreholes will be used for the downgradient injection points

- in addition to HRC™ required for treatment of the VOCs, additional HRC™ will be consumed by competing electron acceptors: 300 Fg/R oxygen, and 6,000 Fg/R ferrous iron (data from natural attenuation parameter monitoring conducted for well PZ013 at Area C during the EE [ABB-ES, 1998])

- seepage velocity is approximately 39 feet per year (ft/year) (assuming a hydraulic conductivity of 20 feet per day [ft/day])

Area D:

- maximum concentrations of PCE, TCE and 1,2-DCE (total) in the upgradient plume area are 470 Fg/R, 100 Fg/R, and 26 Fg/R, respectively; maximum concentrations of TCE and 1,2-DCE (total) in the downgradient plume area are 6,800 Fg/R and 190 Fg/R, respectively

- HRC™ will be injected in three barrier rows with eight, seven, and six injection points, in both the upgradient and downgradient plume areas, for a total of 21 boreholes in each area; half the initial amount of HRC™ will be reinjected through 11 points in each plume area, 2 years following the initial injection

- 1-inch boreholes will be used for the HRC™ injection points

- in addition to HRC™ required for treatment of the VOCs, additional HRC™ will be consumed by competing electron acceptors: 300 Fg/R oxygen, 12,000 Fg/R ferrous iron, and 12,000 Fg/R sulfate (data from natural attenuation parameter monitoring conducted for wells GE002 and TP009 at Area D during the EE [(ABB-ES, 1998])

- seepage velocity is approximately 39 ft/year (assuming a hydraulic conductivity of 20 ft/day)

The estimated dosage of HRC™ for each area are as follows:

	HRC™ Required for Initial Injection	HRC™ Required for Reinjection (2 Years Later)
Area C		
Upgradient Plume Area	595 pounds (lb)	298 lb
Downgradient Plume Area	313 lb	157 lb
Area D		
Upgradient Plume Area	268 lb	134 lb
Downgradient Plume Area	1,142 lb	571 lb

As part of this alternative, groundwater will be monitored for parameters which indicate the likelihood of ongoing and potential future biodegradation, in order to assess the effectiveness of enhanced biodegradation as a treatment for the intermediate zone of the shallow aquifer at OU 3. At each hot spot area (i.e., Areas C and D) it was assumed that a combination of new and existing wells will be used for groundwater monitoring to effectively monitor plume size, chemical concentrations, and movement of the groundwater plume.

In order to effectively assess the performance of HRC™ injection and confirm that reductive dechlorination is occurring, monitoring will be performed quarterly. Groundwater monitoring will be continued until the five-year site review. It is assumed that the treatment duration for this alternative at each area will be 4 years; however, quarterly monitoring will continue until the five-year review to ensure that contaminant levels remain in compliance with action levels after the last application of HRC™.

Analytical results from groundwater sampling conducted during the OU 3 RI showed detections of a select number of compounds at Areas C and D at concentrations exceeding their respective ARARs/To Be Considered (TBCs). The RI concluded that a number of the chlorinated solvent compounds detected at Areas C and D (and arsenic at Area D) also contribute to risk for the evaluated exposure pathways (refer to Table 2-11). Therefore, the quarterly monitoring program for evaluating enhanced biodegradation at both areas will include groundwater sampling and analysis for target compound list (TCL) VOCs at each area and TAL inorganics at Area D, only. In addition, analysis for volatile fatty acids (i.e., lactic acid) will be included to monitor the presence of HRC™ parameters in the aquifer. Sampling and analysis of natural attenuation parameters (specified in the OU 3 FS) will also be conducted. Measurement of these parameters over time will help determine whether or not enhanced biodegradation is effective in reducing chemical concentrations and ultimately reducing risks to industrial human receptors. Groundwater samples will be collected quarterly from a combination of existing and newly installed wells at each area. As specified in the OU 3 FS, it is assumed that samples will be collected from 7 wells at Area C and 9 wells at Area D. A summary report, including groundwater fate and transport modeling, will be prepared to evaluate and summarize the data collected during each annual monitoring event.

Prior to implementing this alternative for Area C or D, a groundwater monitoring plan will be prepared detailing well placement, sampling frequency, and the analytical program. This plan will be submitted for regulatory review and approval prior to implementation. In addition, pilot-scale tests will be necessary to collect design information for implementing full-scale applications of this technology. The pilot study will be designed to establish: 1) the quantity of HRC™ needed for full scale implementation; 2) an estimated treatment duration; and 3) the optimum placement of HRC™ injection points.

Summary of the Estimated Remedy Costs. The estimated present worth costs of the enhanced biodegradation alternative for groundwater Areas C and D are summarized in Tables 2-31 and 2-32, respectively. The estimated total present worth costs for the enhanced biodegradation alternative are: $819,300 for Area C and $956,600 for Area D.

Direct costs for the enhanced biodegradation alternative include site preparation, installation of new monitoring wells, installation of an HRC™ injection system, purchasing equipment for field measurements of some natural attenuation parameters, groundwater use restrictions, and a treatability study. Indirect costs include health and safety costs, administrative fees, engineering and design, and construction support services. The total treatment duration of the enhanced biodegradation alternative is estimated to be 4 years for each area. Administrative O&M costs include annual groundwater monitoring for 5 years and one five-year site review. Treatment system O&M includes reinjection of HRC™ 2 years after the initial injection. The cost of treatment system O&M for this alternative was calculated as a present value. Because treatment system O&M for the enhanced biodegradation alternative involves a single reinjection of HRC™ 2 years after the initial injection, this was treated as a single, lump sum future cost. Therefore, the present value of HRC™ reinjection was calculated and added to the present worth administrative O&M costs to determine the total O&M costs.

The estimated costs for the enhanced biodegradation remedy at Area C and Area D may be refined as a result of remedy changes made during the design and implementation phases. The estimated costs presented in Tables 2-31 and 2-32 are expected to be within +50 to -30 percent of the actual project cost.

Expected Outcomes of the Selected Remedy. Based on the ongoing natural degradation of VOCs in the OU 3 groundwater and published experience (Regenesis) with the use of HRC™ remediate chlorinated VOCs, it is assumed that enhanced biodegradation will effectively destroy the VOCs in the intermediate zone of the surficial aquifer at Areas C and D. This alternative is expected to achieve the RAO for OU 3 groundwater at both areas by achieving ARARs. Table 2-20 presents a summary of the chemicals detected in the groundwater at Areas C and D at levels exceeding selected criteria (action levels) for *in situ* groundwater treatment, as defined in the OU 3 FS.

Implementation of groundwater use restrictions until RAOs have been achieved will ensure protection of human health. Enhanced biodegradation is expected to achieve treatment levels at Areas C and D within 5 years, reducing VOCs permanently and irreversibly such that no controls (administrative or physical) of residual risk will be required.

<u>Area F</u>: Chemical oxidation was selected as the preferred remedial alternative for groundwater at Area F.

Summary of the Rationale for the Selected Remedy. Chemical oxidation at Area F is a relatively low cost alternative with a short implementation time (5 years for remediation, 5 years for treatment system O&M, and 10 years for administrative O&M to allow for two 5-year site reviews). In addition, chemical oxidation is an active *in situ* treatment technology. The creation of a treatment cell

Table 2-31
Cost Summary Table for the Enhanced Biodegradation Alternative for Groundwater, Area C

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Others Areas
of Elevated Groundwater Contamination, Operation Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Cost Item	Cost
Direct Costs	
Site Preparation	\$27,400
HRC™ Injection System	\$101,500.00
Installation of New Wells for Groundwater Monitoring	\$26,600.00
Purchasing of Equipment for Monitoring	\$2,200.00
Groundwater Use Restriction	\$5,000.00
Treatability Studies	\$20,000.00
Total Direct Cost	\$182,700
Indirect Costs	
Health and Safety (10% of Total Direct Cost)	\$18,300
Administrative and Permitting (5% of Total Direct Cost)	\$9,100
Engineering and Design (15% of Total Direct Cost)	\$27,400
Construction Support Services (15% of Total Direct Cost)	\$27,400
Total Indirect Cost	\$82,200
Total Capital Cost (Direct + Indirect)	\$264,900
Operation and Maintenance (O&M) Costs	
Administrative O&M	
Quarterly Groundwater Monitoring, annual cost	\$94,100
Five-Year Site Reviews (annualized)	\$7,400
Present Worth - Administrative O&M (Discount Rate of 6%, 5 years)	\$427,600
Treatment System O&M	
HRC™ O&M - Present Value of Single Lump Sum Cost for Reinjection 2 Years After Initial Injection (Discount Rates of 6%, 2 years)	\$52,300
Total O&M Cost (Present worth)	\$479,900
Total Capital and O&M Cost	\$744,800
Contingency (10% of Total Capital and O&M Cost)	\$74,500
Total Cost of Enhanced Biodegradation Groundwater Alternative - Area C	\$819,300

Notes: 1)Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest \$100.

HRC™ = hydrogen release compound.
% = percent.
PSC = potential source of contamination.
OU = operable unit.

Table 2-32
Cost Summary Table for the Enhanced Biodegradation Alternative for Groundwater, Area D

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Others Areas of Elevated Groundwater Contamination, Operation Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Cost Item		Cost
Direct Costs		
Site Preparation		$27,400
HRC™ Injection System		$104,800.00
Installation of New Wells for Groundwater Monitoring		$26,200.00
Purchasing of Equipment for Monitoring		$2,200.00
Groundwater Use Restrictions		$5,000.00
Treatability Studies		$20,000.00
	Total Direct Cost	$185,600
Indirect Costs		
Health and Safety (10% of Total Direct Cost)		$18,600
Administrative and Permitting (5% of Total Direct Cost)		$9,300
Engineering and Design (15% of Total Direct Cost)		$27,800
Construction Support Services (15% of Total Direct Cost)		$27,800
	Total Indirect Cost	$83,500
	Total Capital Cost (Direct + Indirect)	$269,100
Operation and Maintenance (O&M) Costs		
Administrative O&M		
Quarterly Groundwater Monitoring, annual cost		$123,000
Five-Year Site Reviews (annualized)		$7,400
	Present Worth - Administrative O&M (Discount Rate of 6%, 5 years)	$549,300
Treatment System O&M		
HRC™ O&M - Present Value of Single Lump Sum Cost for Reinjection 2 Years After Initial Injection (Discount Rates of 6%, 2 years)		$51,200
	Total O&M Cost (Present Worth)	$600,500
	Total Capital and O&M Cost	$869,600
	Contingency (10% of Total Capital and O&M Cost	$87,000
Total Cost of Enhanced Biodegradation Groundwater Alternative - Area D		$956,600

Notes: 1) Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.

HRC™ = hydrogen release compound.
% = percent.
PSC = potential source of contamination.
OU = operation unit.

through the combined injection and extraction of groundwater will control the hydraulic flow paths within the plume, preventing VOC migration during remediation.

Description of the Selected Remedy. Chemical oxidation consists of injecting an oxidant into the groundwater at OU 3 to chemically destroy the chlorinated compounds. For the purpose of alternative development, it was assumed that $KMnO_4$ will be the oxidant injected into the aquifer to destroy the VOCs. Chemical oxidation using $KMnO_4$ oxidizes contaminants via the permanganate ion (MnO_4^-). Treatment involves the flushing of the contaminated zone using an aqueous permanganate solution.

Prior to implementing full scale application of chemical oxidation at Area F, a pilot-scale test will be necessary to collect design information for this innovative technology. The pilot study will be designed to establish: (1) the feasibility of injecting and adequately distributing the potassium permanganate solution in the contaminated area; (2) an estimate of destruction efficiency; and (3) the optimum concentration of oxidant in the solution.

A combination of extraction and injection wells will be used for chemical oxidation of the contaminated groundwater at Area F. Groundwater is extracted, dosed with $KMnO_4$, and then reinjected at an upgradient location. This creates a treatment cell, allowing flushing of several pore volumes of solution through the contaminated zone until the contaminants have been oxidized.

The groundwater flow model Visual MODFLOW (version 2.7.1) was used to develop a conceptual design for the $KMnO_4$ injection system for this alternative. Results of the MODFLOW simulations are included in the OU 3 FS. The modeling suggested that 10 injection wells at a flow rate of 0.75 gallons per minute and 5 extraction wells at flow of 1.5 gallons per minute will provide effective oxidant flushing in the groundwater plume at Area F.

Each extraction and injection well will be a 4-inch diameter, polyvinyl chloride (PVC)-cased well. The wells at Area F will be screened across the upper 15 feet of the intermediate portion of the shallow aquifer (approximately 15 to 30 feet bls).

Groundwater from extraction well(s) is pumped to an equalization tank. A transfer pump will deliver the extracted water to the $KMnO_4$ feed system, where oxidant is added. Oxidant will be delivered to the site and stored in 330-pound (lb) (30-gallon) drums. The $KMnO_4$ will be metered into the extracted groundwater stream by an automated drum inverter system and a feeder hopper. After dosage, the treated groundwater will be pumped to two tanks piped in series and equipped with agitators. These tanks will provide the required residence time to allow the $KMnO_4$ to oxidize any VOCs present in the extracted groundwater, and ensure that the added $KMnO_4$ (which is fed as a powder) is completely dissolved. The treated water is then pumped through a filter to remove particulates, and distributed via appropriate valving and flow meters to the injection wells.

The anticipated dosage of $KMnO_4$ for chemical oxidation of VOCs at Area F is 250 milligrams per liter (mg/ℓ). At that dosage, the estimated $KMnO_4$ consumption for the duration of this alternative is 39,400 lbs at Area F. After the first pore volume of groundwater is flushed, the extracted groundwater will likely have residual, unconsumed $KMnO_4$ remaining. In this case, the $KMnO_4$ feed will only be makeup to reach 250 mg/ℓ. However, the cost of this alternative assumes a feed rate of 250 mg/ℓ of $KMnO_4$ will be required for the full duration of treatment. The anticipated residence time required for the $KMnO_4$ to oxidize VOCs in the extracted groundwater is one hour. The anticipated $KMnO_4$ dosage and residence time for chemical oxidation at Area F is based on operation of a similar system for treatment of TCE at a Department of Energy site in Portsmouth, New Hampshire.

The estimated treatment duration was based on the assumption that two to three pore volumes of flushing will be necessary to effectively contact the oxidant with the entire groundwater plume (based on literature values). The treatability study will determine the actual number of pore volumes that must be flushed to adequately treat the contaminated groundwater. The estimated treatment duration for this alternative is 5 years.

The chemical oxidation alternative includes monitoring of groundwater for VOCs and TAL inorganics to monitor the utilization of the injected $KMnO_4$. In order to evaluate the effectiveness of the chemical oxidation system and assure appropriate dosage and residence time for the oxidant throughout implementation of this alternative, system monitoring will be performed. The treatment system monitoring proposed for Area F includes sampling of groundwater as it is extracted, and after it is mixed with the $KMnO_4$, prior to injection. The extraction and injection wells will be monitored for TCL VOCs and TAL inorganics. It was assumed that 5 wells (3 existing and 2 newly installed) will be sampled for the annual groundwater monitoring. The proposed frequency and number of wells to be included in the treatment system monitoring is included in the OU 3 FS.

For the five-year site reviews, treatment system performance will be summarized and evaluated. This evaluation will include an assessment of the reduction in VOC concentrations in the groundwater, an evaluation of compliance with action levels, and a review of the effectiveness of chemical oxidation.

Summary of the Estimated Remedy Costs. The estimated present worth cost of the chemical oxidation alternative for groundwater Area F is summarized in Table 2-33. The estimated total present worth cost for the chemical oxidation alternative is $1,178,300 for Area F.

Direct costs for the chemical oxidation alternative include site preparation, installation of a groundwater injection/extraction well system and chemical oxidation treatment system, installation of new monitoring wells, groundwater use restrictions, and a treatability study. Indirect costs include health and safety costs, administrative fees, engineering and design, and construction support services. The total treatment duration of the chemical oxidation alternative is estimated to be 5 years. Administrative O&M costs include annual groundwater monitoring and five-year site reviews until the first review period after RAOs have been achieved (e.g., for an estimated treatment duration of 5 years it was assumed that two, five-year site reviews will be conducted). Treatment system O&M includes system maintenance and utilities costs.

The estimated costs for the chemical oxidation remedy at Area F may be refined as a result of remedy changes made during the design and implementation phases. The estimated costs presented in Table 2-33 are expected to be within +50 to -30 percent of the actual project cost.

Table 2-33
Cost Summary Table for the Chemical Oxidation Alternative for Groundwater, Area F

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Others Areas of Elevated Groundwater Contamination, Operation Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Cost Item		Cost
Direct Costs		
Site Preparation		$41,300
In Situ Chemical Oxidation Treatment System		$84,700
Groundwater Injection/Extraction Well System		$213,300
Installation of New Wells for Groundwater Monitoring		$11,100
Groundwater Use Restrictions		$5,000
Treatability Studies		$20,000
	Total Direct Cost	$375,400
Indirect Costs		
Health and Safety (10% of Total Direct Cost)		$37,500
Administrative and Permitting (5% of Total Direct Cost)		$18,800
Engineering and Design (20% of Total Direct Cost)		$75,100
Construction Support Services (20% of Total Direct Cost)		$75,100
	Total Indirect Cost	$206,500
	Total Capital Cost (Direct + Indirect)	$581,900
Operation and Maintenance (O&M) Costs		
Administrative O&M		
Annual Groundwater Monitoring		$18,800
Five-Year Site Reviews (annualized)		$7,400
	Present Worth - Administrative O&M (Discount Rates of 6%, 10 years)	$192,800
Treatment System O&M		
Present Worth - Chemical Oxidation System Maintenance (Discount Rates of 6%, 5 years)		$256,100
Present Worth - Utilities (Discount Rates of 6%, 5 years)		$40,400
	Present Worth - Treatment System O&M	$296,500
	Total O&M Cost (Present Worth)	$489,300
	Total Capital and O&M Cost	$1,071,200
	Contingency (10% of Total Capital and O&M Cost)	$107,100
	Total Cost of Chemical Oxidation Groundwater Alternative - Area F	$1,178,300

Notes: 1) Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.

% = percent.
PSC = potential source of contamination.
OU = operable unit.

Expected Outcome of the Selected Remedy. Based on published literature, it is anticipated that chemical oxidation with $KMnO_4$ will be able to destroy up to 90 to 95 percent of the contaminant mass at Area F. This alternative is expected to achieve the RAO for the groundwater by achieving ARARs. Table 2-20 presents a summary of the chemicals detected in the groundwater at Area F which exceed selected criteria (action levels) for *in situ* groundwater treatment, as defined in the OU 3 FS. Implementation of groundwater use restrictions until RAOs have been achieved will ensure protection of human health. Chemical oxidation is expected to achieve treatment levels at Area F within 5 years, reducing VOCs permanently and irreversibly such that no controls (administrative or physical) of residual risk will be required.

Areas B and G: The selected remedy for Areas B and G has been modified since the publication of the Proposed Plan (HLA, 2000). Based on public input (as summarized in the Responsiveness Summary in Chapter 3.0), the selected remedy for Areas B and G is monitored natural attenuation. The following paragraphs will discuss MNA as it applies to Areas B and G, noting elements of the alternatives that are specific to a particular area (e.g., cost).

Summary of the Rationale for the Selected Remedy. In response to comments from the RAB, the Partnering Team has agreed that aggressively remediating plumes at Areas B and G will not be cost effective at this time. The RI documented that natural attenuation is occurring in the Operable Unit. The plume at Area G has been shown to be attenuating with a half-life of 13.5 years and is predicted to decay to nondetectable levels in 39 years, before the plume reaches the St. Johns River. Although the attenuation rate at Area B has not been determined, the USGS groundwater model predicts the plume will slowly migrate into the clay plug (totally within the clay after 41 years) and not emerge for more than 200 years, during which time it is anticipated to decay to nondetectable levels. Therefore, the initial preferred remedies, as outlined in the Proposed Plan, have been changed to MNA. MNA at Area B and Area G is a relatively low cost alternative, even though it has a moderate to long implementation time. There are no treatment residuals or utilities maintenance. This alternative does not require any underground piping or above ground equipment, it only requires a few monitoring wells.

Description of the Selected Remedy. MNA consists of periodic monitoring of the natural attenuation processes (including biodegradation, dispersion, dilution, sorption, volatilization, chemical or biological stabilization, transformation, or destruction) upgradient, within and downgradient of the plume. Monitoring wells will be sampled and groundwater will be analyzed for parameters which indicate the likelihood of ongoing and potential future biodegradation as well as groundwater contaminants.

Sampling events will be conducted every 6 months for 2 years, then annually for 3 years until the 5-year review, and finally biannually. Groundwater samples will be collected from monitoring wells at Area G and Area B. Evaluation of chemical analysis data will be conducted to ensure the process is working and to verify USGS model predictions of plume movement and decay. In particular, for Area G the prediction of decay within 39 years, before the plume reaches the St. Johns River, requires verification; and for Area B the predictions of the plume moving along the channel fill deposits (clay plug) and that the plume is undergoing decay require verification.

If, at the end of 5 years of MNA data collection, it is determined that the plumes are behaving differently than what the USGS model indicates or that MNA will not achieve Federal and State MCLs for COCs within 41 years at Area B and 39 years at Area G, then a contingent action would be implemented. The contingent action would be to revert to the original selected alternatives, enhanced biodegradation for Area B and chemical oxidation for Area G, or other innovative technology which provides for active remedial action.

Summary of the Estimated Remedy Costs. The estimated present worth costs of the MNA alternative for groundwater at Areas B and G are summarized in Tables 2-34 and 2-35, respectively. The estimated total present worth costs for the MNA alternative are: $462,000 for Area B and $581,900 for Area G.

Direct costs for the MNA alternative include site preparation, installation of monitoring wells, purchasing equipment for field measurements of some natural attenuation parameters, and groundwater use restrictions. Indirect costs include health and safety costs, administrative fees, engineering and design, and construction support services. The total treatment duration of the MNA alternative is estimated to be 39 years for Area G and 41 years for Area B. Administrative O&M costs include groundwater monitoring for the duration of treatment and five-year reviews.

The estimated costs for the MNA remedy at Areas B and G may be refined as a result of remedy changes made during the design and implementation phases. The estimated costs presented in Tables 2-34 and 2-35 are expected to be within +50 to -30 percent of the actual project cost.

Expected Outcomes of the Selected Remedy. Based on the observed and modeled ongoing natural attenuation and groundwater flow patterns at OU 3, it is assumed that MNA will effectively destroy the VOCs at both Area B and Area G. This alternative is expected to achieve the RAO for groundwater at Areas B and G by achieving ARARs. Table 2-20 presents a summary of the chemicals detected in groundwater at Areas B and G at levels exceeding criteria (action levels) for in situ groundwater treatment as defined in the OU 3 FS.

Implementation of groundwater use restrictions until RAOs have been achieved will ensure protection of human health. MNA is expected to achieve the RAOs at Areas B and G within 41 and 39 years respectively, reducing VOCs permanently and irreversibly such that no controls (administrative or physical) of residual risk will be required.

<u>Sediment</u> The preferred remedial alternative for sediment adjacent to PSC 16 is selective removal of tar balls.

Summary of the Rationale for the Selected Remedy. Tar balls embedded in the sediment were observed during a sediment depositional characterization performed south of the PSC 16 outfall in April 1999. A tar ball was found at the location of a sediment sample where prior toxicity testing indicated 100% mortality, as well as other locations noted on Figure 2-18. It is believed that the contaminants contributing to aquatic receptor toxicity are primarily contained within these tar balls that have formed over time. Therefore, the remedial alternative selected for treatment of the OU 3 sediment is one which is expected to effectively limit exposure of aqueous species to the tar balls.

Table 2-34
Cost Summary Table for the Natural Attenuation Alternative for Groundwater, Area B

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Cost Item	Cost
Direct Costs	
Installation of New Wells for Groundwater Monitoring	$27,800
Purchase of Equipment for Natural Attenuation Monitoring	$2,200
Groundwater Use Restrictions	$5,000
Total Direct Cost	$35,000
Indirect Costs	
Health and Safety, HASP	$9,700
Engineering and Administration, SAP	$9,900
Total Indirect Cost	$19,600
Total Capital Cost (Direct + Indirect)	$54,600
Operation and Maintenance (O&M) Costs	
Scheduled Natural Attenuation Groundwater Monitoring (semi-annual, 2 years; annual, 3 years; biannual to year 41)	$10,600
Scheduled Groundwater Modeling/Reporting (annual for 5 years; biannual to year 41)	$6,700
Five-Year Site Reviews (annualized)	$7,400
Present worth of O&M (Discount Rate of 6%, 41 years)	$365,400
Total Capital and O&M Cost	$420,000
Contingency (10% of Total Capital and O&M Cost)	$42,000
Total Cost of Natural Attenuation Groundwater Alternative - Area B	$462,000

Notes: 1) Costs have been rounded to the nearest $100 for this estimate.

HASP = health and safety plan.
SAP = sampling and analysis plan.
% = percent.

Table 2-35
Cost Summary Table for the Natural Attenuation Alternative for Groundwater, Area G

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Cost Item	Cost
Direct Costs	
Installation of New Wells for Groundwater Monitoring	$26,900
Purchase of Equipment for Natural Attenuation Monitoring	$2,200
Groundwater Use Restrictions	$5,000
Total Direct Cost	$34,100
Indirect Costs	
Health and Safety, HASP	$9,700
Engineering and Administration, SAP	$9,900
Total Indirect Cost	$19,600
Total Capital Cost (Direct + Indirect)	$53,700
Operation and Maintenance (O&M) Costs	
Scheduled Natural Attenuation Groundwater Monitoring (semi-annual, 2 years; annual, 3 years; biannual to year 39)	$15,300
Scheduled Groundwater Modeling/Reporting (annual for 5 years; biannual to year 39)	$11,400
Five-Year Site Reviews (annualized)	$7,400
Present worth of O & M (Discount Rate of 6%, 39 years)	$475,300
Total Capital and O&M Cost	$529,000
Contingency (10% of Total Capital and O&M Cost)	$52,900
Total Cost of Natural Attenuation Groundwater Alternative - Area G	$581,900

Notes: 1) Costs have been rounded to the nearest $100 for this estimate.

HASP = health and safety plan.
SAP = sampling and analysis plan.
% = percent.

Description of the Selected Remedy. This alternative will be achieved by sifting through the sediment adjacent to the PSC 16 outfall to remove the tar balls. The proposed extent of remediation encompasses the sediment probing locations at which tar balls were observed during the depositional characterization performed in April 1999 (Figure 2-18). The initial step for this alternative is analytical and/or toxicity testing to confirm or change, if needed, the remediation boundary shown on Figure 2-18. The details of this sampling will be agreed upon by the Partnering Team. However, for the purposes of remedy selection it is assumed that sediment samples will be collected from 10 locations, and analyzed for PAHs, lead, grain size, and total organic carbon, and 10-day toxicity testing to measure survival and growth of *L. plumulosus*. A silt screen containment barrier will be installed around the remediation boundary to limit offsite migration of any sediment that may be resuspended during remediation.

A device will be fashioned to manually sift through the sediment and remove the tar balls. The FS for OU 3 assumed that a manually controlled raking device will be used to screen tar balls from the surrounding sediment. An alternate type of device may be specified during the design phase if it accomplishes effective removal of the tar balls. The raking device should penetrate the sediment to a depth of 6 inches. The depth of water in the area to be remediated is shallow enough (refer to Figure 2-18) that the raking could be performed by workers wading in the water, or from the side of a boat.

Bivalve organisms observed during a sediment sampling event in January 1999 will be screened from the sediment by the raking action, but could easily be separated from the extracted tar balls and returned to the river.

The extracted tar balls will be collected in a 55-gallon drum and transported to an offsite landfill for disposal. After the tar ball removal activities have been completed, confirmatory sediment samples will be collected from 5 locations, and analyzed for PAHs, lead, grain size and total organic carbon, and 10-day toxicity testing to confirm removal of the contaminated sediments.

Summary of the Estimated Remedy Costs. The estimated present worth cost of the selective tar ball removal alternative for the OU 3 sediment is summarized in Table 2-36. The cost estimate includes initial sediment sampling, raking the sediment for tar ball removal, disposal of the tar balls, and associated indirect costs. There are no O&M costs associated with this alternative. The present worth of this alternative is estimated to be $79,900. It is estimated that this alternative could be implemented in 1 month.

The estimated costs for the sediment remedy maybe refined as a result of remedy changes made during the design and implementation phases. The estimated costs presented in Table 2-36 are expected to be within +50 to -30 percent of the actual project cost.

Expected Outcomes of the Selected Remedy. The chemicals that are toxic to ecological receptors are believed to be primarily contained within tar balls observed in the sediment at OU 3; therefore, selective removal of the tar balls is expected to mitigate the source of toxicity and prevent future risks to the environment. Promulgated ARARs for sediment are not available; however, the remediation of sediment at OU 3 is expected to satisfy the RAO for sediment by meeting the exposure endpoints selected for the baseline ERA. The selective removal of tar balls is expected to reduce the PAHs and lead in the sediment to

Table 2-36
Cost Summary Table for the Selective Removal of Tar Balls Alternative for Sediment

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Cost Item	Cost
Direct Costs	
Sampling to Confirm Remediation Boundaries	$11,200
Installation of a Containment Barrier	$10,500
Selective Removal of Tar Balls	$13,000
Disposal of Extracted Material	$16,000
Total Direct Cost	$50,700
Indirect Costs	
Health and Safety (10% of Total Direct Cost)	$5,100
Administration and Permitting (5% of Total Direct Cost)	$2,500
Engineering and Design (5% of Total Direct Cost)	$2,500
Construction Support Services (10% of Total Direct Cost)	$5,100
Total Indirect Cost	$15,200
Total Capital Cost (Direct + Indirect)	$65,900
Operation and Maintenance (O&M) Costs	
Confirmatory Sediment Sampling	$6,700
Total O&M Cost (Present Worth)	$6,700
Total Capital and O&M Cost	$72,600
Contingency (10% of Total Capital and O&M Cost)	$7,300
Total Cost of Selective Removal of Tar Balls Alternative for Sediment	$79,900

Notes: 1) Cost estimates may vary depending on assumptions made on interest and inflation rates. An assumed discount rate of 6 percent was used to estimate the alternative costs for OU 3. Costs are rounded to the nearest $100.

PSC - potential source of contamination.
% = percent.
OU = operable unit.

levels that will not adversely affect the survival and growth of amphipods exposed to the sediment, as compared to the upgradient background samples and the laboratory control. Selective removal of the tar balls from the sediment is not expected to have an adverse impact on the overlying surface water.

2.12.2 Selected Remedies for PSC 48, Building 780, PSC 11, PSC 12, PSC 13, PSC 14, and PSC 15 As indicated in Section 2-4, there are several PSCs which are part of OU 3. These PSCs and Building 780 have had site-specific supplemental investigations, risk evaluations, and/or ongoing cleanup activities. The results of these efforts were evaluated in the RI and the preferred remedial actions for these sites are as follows:

PSC 48 and Building 780. As discussed in Section 2.4 of this ROD, IRAs are currently being conducted at PSC 48 and Building 780 at OU 3. The IRAs were initiated at these areas because elevated concentrations of VOCs were detected in environmental media at the sites during previous investigations. The RAOs established during the development of the EE/CA are to reduce present or future risks posed to human health and to the environment and to reduce contaminant concentrations in hot spots or source areas (ABB-ES, 1995a).

The IRA at PSC 48 consists of an air sparge and SVE system. The IRA at Building 780 includes groundwater extraction and pretreatment by air stripping, and soil vapor extraction. Both air sparging and groundwater extraction and pretreatment have been proven to be effective at removing VOCs from groundwater. These technologies have been successfully implemented at numerous other sites having similar contaminants and stratigraphy. Long term data from several of these sites have demonstrated that the technologies were able to lower contaminant concentrations to below action levels (e.g., State or Federal MCLs). Monitoring of the two systems (IRAs at PSC 48 and Building 780) indicate there has been a reduction of contaminants in groundwater at PSC 48 (HLA, 1999a) and that contaminants are being removed from both the groundwater and the vadose zone at Building 780 (HLA, 1999b). It appears, therefore, that the remedial systems at both sites are effectively removing contaminants. As indicated in the EE/CA for Buildings 106 and 780 (ABB-ES, 1995b), these technologies will meet ARARs and will comply with RAOs for OU 3 groundwater over time.

Based on a review of the ongoing monitoring results for the IRAs at PSC 48 and Building 780, the NAS Jacksonville Partnering Team determined that the systems are effectively removing contaminants from the groundwater, thereby reducing the toxicity and volume of contaminants while providing protection to human health and the environment. Therefore, the remedial systems should continue operation at these locations and should be considered the selected remedy.

The long-term plan for the ongoing IRAs is to continue operation and maintenance of the systems and groundwater monitoring until the 5-year review. At the 5-year review, the performance of each system is to be evaluated. The objective during the 5-year review will be to determine if the VOC concentration (expressed as the total ethene equivalent) in groundwater is decreasing such that ARARs will be met in a reasonable timeframe (e.g., 30 years).

If groundwater concentrations are decreasing at a satisfactory rate, then the remedial systems at PSC 48 and Building 780 should continue with appropriate LUCs. If the NAS Jacksonville Partnering Team agrees that either of the technologies is not working, then either the groundwater contamination cannot be removed by the current technology and an alternate concentration limit should be set; a different remedial technology should be developed; or a technical impracticability waiver should be sought.

PSC 11 No further remedial action planned (NFRAP) based on no unacceptable risk to human or ecological receptors.

PSC 12 NFRAP based on no unacceptable risk to human or ecological receptors.

PSC 13 NFRAP based on a previous removal action and clearance of the site for unrestricted use by the U.S. Navy Radiological Affairs Support Office (RASO, 1995).

PSC 14 NFRAP with land use controls based on no unacceptable risk to human or ecological receptors in an industrial setting.

PSC 15 NFRAP with land-use controls based on no unacceptable risk to human or ecological receptors in an industrial setting.

2.13 STATUTORY DETERMINATIONS. The remedial actions selected for implementation at OU 3 are consistent with CERCLA and the NCP. The selected remedies for the storm sewer water, groundwater, and sediment satisfy the statutory preference for treatment to the extent practicable, which permanently and significantly reduces the mobility, toxicity, and/or volume of hazardous substances as a principal element.

A comparison of the selected remedy for the storm sewer water with the nine evaluation criteria is made in Table 2-37. The three selected groundwater remediation technologies (enhanced biodegradation for Areas C and D, chemical oxidation for Area F, and monitored natural attenuation for Areas B and G) are compared to the nine evaluation criteria in Tables 2-38, 2-39, and 2-40, respectively. A comparison of the selected remedy for sediment at OU 3 with the nine evaluation criteria is presented in Table 2-41.

A summary of the identified ARARs specific to the storm sewer remedy, enhanced biodegradation remedy for Areas C and D groundwater, chemical oxidation remedy for Area F groundwater, MNA for Areas B and G, and the sediment remedy are provided in Table 2-42. Because ARARs are legally enforceable standards, they must be met by the selected remedies for each media.

Because the selected remedies for OU 3 storm sewer water and groundwater may result in hazardous substances remaining onsite, a review will be conducted within 5 years after commencement of the remedial actions to ensure that the remedies continue to provide adequate protection of human health and the environment.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES. The Proposed Plan for OU 3 was released in April 2000. The Navy reviewed all written and verbal comments submitted during the public comment period (see Chapter 3.0 for details). Based on the feedback provided to USEPA and FDEP by the community, two changes have been made in the selection of preferred remedial alternatives presented in the Proposed Plan.

Table 2-37
Comparison of Selected Storm Sewer Remedy with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Overall Protection of Human Health and the Environment	The risk assessment for OU 3 did not predict unacceptable risk to human health or the environment based on exposure to VOCs detected in the storm sewer water. However, remediation is needed to comply with Florida Surface Water Standards (FSWS). This alternative is expected to mitigate the source of contamination in the storm sewer water (through either remediation of the Area F groundwater or installation of CIPP) and to eliminate the potential for migration of contaminated groundwater to the St. Johns River via the storm sewers.
Compliance with ARARs	The selected storm sewer alternative will comply with ARARs (FSWS), whether it is as a result of remediation of the Area F groundwater or infiltration control with CIPP. If installation of CIPP in the storm sewers is necessary, this alternative will include removal of contaminated storm sewer water in the portion of sewers to be remediated. After the source of contamination is abated, any residual VOCs present within the sewer should quickly dissipate by both dilution with the fluctuating tide water from the St. Johns River within the sewer and volatilization of the storm water as it travels through the sewer.
Long-term Effectiveness	The selected remedial alternative for the Area F groundwater (chemical oxidation) offers a long-term and permanent remedy for VOC contamination in groundwater. Therefore, cleanup of that suspected source of chemicals in the storm sewer water is expected to result in a permanent reduction of VOCs in the storm sewer water. If remediation of Area F groundwater does not result in compliance of the storm sewer water with ARARs, CIPP offers a long-term and permanent remedy against infiltration of contaminated groundwater into the rehabilitated section of the storm sewer. Vendors report the design life of CIPP to be 50 years. Once the most likely source of VOC contamination in the sewers has been eliminated, compliance with the FSWS within the zone of tidal influence should be easily maintained, unless there are other sources of contamination In the storm sewer. CIPP is considered a reliable control for infiltration of groundwater into storm sewers. In addition to eliminating groundwater infiltration, CIPP improves the structural integrity of a sewer line.
Reduction of Toxicity, Mobility, and Volume	This alternative does not include direct treatment of the contaminants in the storm sewers. Instead, it treats (as a result of Area F groundwater remediation) or controls (by installation of CIPP) an ongoing source of contamination. Implementation of chemical oxidation at Area F will reduce the toxicity, mobility, and volume of VOCs in the groundwater, and is expected to result in a reduction of toxicity and volume of chemicals in the storm sewer water. Groundwater remediation at Area F will not affect the mobility of chemicals in the OU 3 storm sewer water. If CIPP is installed in the storm sewer pipes, this alternative will reduce the toxicity, mobility, and volume of organics in the storm sewer water through removal of the contaminated water prior to CIPP installation. Once groundwater infiltration has been abated, natural processes within the storm sewer (i.e., volatilization and dilution) may reduce the concentration of any residual VOCs remaining in the sewers, prior to discharge to the St. Johns River.

See notes at end of table.

Table 2-37 (Continued) Comparison of Selected Storm Sewer Remedy with Nine Evaluation Criteria Record of Decision PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3 Naval Air Station Jacksonville Jacksonville, Florida	
Evaluation Criteria	**Assessment**
Short-term Effectiveness	The selected alternative for the OU 3 storm sewer water involves waiting for the completion of groundwater remediation at Area F to determine whether or not that activity brings the storm sewer water into compliance with the FSWS. The estimated treatment time for chemical oxidation at Area F is 5 years. Monitoring of the storm sewer water will be performed after remedial activities at Area F are complete to determine whether or not CIPP installation is necessary. CIPP could be installed in a short amount of time, quickly eliminating the probable source of contamination (infiltrating groundwater) if not already accomplished by remediation of Area F groundwater. Prior to CIPP installation, contaminated water in the portion of sewer being remediated will be removed, bringing the storm sewers into compliance with the FSWS with minimal exposure to site workers. This alternative Is expected to achieve RAOs soon after implementation, with no adverse environmental effects. It is assumed that storm sewer water monitoring will be conducted for 5 years, and only one five-year site review will be performed. Site workers entering the storm sewers during remedial activities for CIPP installation will be required to follow appropriate practices for safe work (e.g., adequate PPE, air quality monitoring, and other stipulations for work conducted in a confined space). There are no known health and safety concerns associated with the installation of CIPP. If necessary, booms could be placed around the outfall of the storm sewer during installation of CIPP as a precaution against the release of resin into the river.
Implementability	If the remediation of the Area F groundwater effectively reduces VOCs in the storm sewer water to concentrations below the FSWS, this alternative will require only storm sewer water monitoring, which is easily implemented. If CIPP is deemed necessary, there are several available vendors for installation. Installation of CIPP is relatively straightforward. Isolation of the 60-inch storm sewer pipes, including plugging, removal of water and sediment, and potential pressure washing, will be required prior to installation of the liner. The isolated section of the storm sewer will be plugged at both ends, upgradient (to block flow travelling toward the outfall) and downgradient (to block tidal flow from the St. Johns River). Water above the upgradient plug will be diverted around this section of sewer while work is being conducted. Storm water will be pumped from the isolated section of the storm sewer and containerized. Samples will be collected to determine whether or not the water is acceptable for discharge to the FOTW. If any parameters exceed influent criteria for the FOTW, the water will require pretreatment prior to discharge to the treatment plant. Sediment will be removed from the sewers, containerized, sampled and analyzed, and disposed of at an appropriate off-site facility. Sampling of the storm sewer water and five-year site reviews are easily implemented.
Cost	The storm sewer water sampling costs associated with the selected storm sewer alternative will be accounted for by the ten percent cost contingency for the Area F groundwater alternative. If storm sewer water sampling results following the Area F groundwater remediation indicate that further action is necessary for the storm sewers, CIPP will be installed in the OU 3 storm sewer at an estimated present worth cost of $2,127,300 (summarized in Table 2-30).
Federal and State Acceptance	The USEPA and FDEP have concurred with the selected remedy for the OU 3 storm sewer water.
See notes at end of table.	

Table 2-37 (Continued)
Comparison of Selected Storm Sewer Remedy with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Community Acceptance	The community has been given the opportunity to review and comment on the selected remedy. They felt it was wise to delay installation of the CIPP and see if the Area F groundwater remediation lowered the VOC contamination in the storm sewer to below the Florida Surface Water Standards. Comments received were addressed (see Chapter 3.0) and did not after the selected remedy proposed in the proposed plan.

Notes: OU = operable unit.
CIPP = cured-in-place pipe.
FDEP = Florida Department of Environmental Protection.
ARAR = applicable or relevant and appropriate requirement.
USEPA = U.S. Environmental Protection Agency.
PSC = potential source of contamination.
VOCs = volatile organic compounds.
RAOs = remedial action objectives.
PPE = personal protection equipment.
FOTW = Federally-owned treatment works.

Table 2-38
Comparison of Selected Groundwater Remedy for Area C and Area D with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Overall Protection of Human Health and the Environment	The risk assessment for OU 3 predicted unacceptable risk to human health under future groundwater use assumptions (adult occupational worker). The enhanced biodegradation alternative will provide protection to future human receptors who may use OU 3 groundwater as a potable water supply. Humans will be protected in the short term because groundwater use restrictions will prohibit the consumption of water from the aquifer until complete aquifer restoration (i.e., when action levels are achieved). Injection of HRC™ will enhance the ongoing natural attenuation of contaminants in the intermediate zone of the shallow aquifer. This reduction in VOC concentrations will eventually eliminate human health risks associated with the groundwater. The combination of in situ groundwater treatment and implementation of groundwater use restrictions will ensure that human health is properly protected in both the short- and long-term. By implementing this alternative, no adverse short-term or cross-media effects are anticipated.
Compliance with ARARs	Implementation of this alternative will achieve chemical-specific ARARs for VOCs in the groundwater through enhanced biological mechanisms. This alternative will not directly reduce the concentrations of inorganic analytes at Area D, such as arsenic, which contributes directly to human health risk, and manganese, which exceeds its chemical-specific ARAR. However, the treatment of organics may indirectly reduce the concentration of inorganic analytes. Groundwater monitoring is included in this alternative to evaluate compliance with ARARs. This alternative will require compliance with action-specific ARARs, such as the Federal and State regulations for underground injection control (refer to Table 2-19).
Long-term Effectiveness	Enhanced biodegradation is an emerging technology that shows great promise at biologically destroying chlorinated solvents permanently, especially when ongoing natural attenuation has been observed at OU 3 (ABB-ES, 1998). Pilot studies performed at other sites and available vendor information can provide assistance on assessing the ability of HRC™ to enhance the complete dechlorination of chlorinated VOCs. Prior to implementing this alternative at Areas C and D, field pilot tests will be performed to optimize the injection distribution, quantity, and frequency of HRC™ injections. It is anticipated that a treatment duration of 4 years will be required at Areas C and D to comply with RAOs.
Reduction of Toxicity, Mobility, and Volume	This alternative will accelerate reduction in toxicity and volume of VOCs in groundwater by enhancing the natural degradation processes. During degradation, enhanced biodegradation will not provide a significant reduction in contaminant mobility. However, the estimated duration of treatment is only 4 years at Areas C and D and therefore significant migration of the plume before biological destruction is not likely. Enhanced biodegradation will biologically destroy the VOCs in situ in the groundwater plumes at Areas C and D. Therefore, no treatment residuals are produced by this alternative.

See notes at end of table.

Table 2-38 (Continued)
Comparison of Selected Groundwater Remedy for Area C and Area D with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Short-term Effectiveness	It is estimated that the enhanced biodegradation alternative will require only 4 years of implementation at Areas C and D to comply with RAOs. Groundwater-use restrictions will be implemented to provide the required short-term effectiveness in protecting the future occupational worker from the existing contamination during remedy implementation. There will be no exposure risks to workers installing the boreholes for HRC™ injection if DPT is utilized. Other than well installation, remedial construction activities are not proposed under this alternative. This alternative poses only a minimum threat to site workers through exposure to contaminated groundwater during monitoring activities. These activities will not pose a risk to the community.
Implementability	Injection of HRC™ requires only basic drilling techniques. Heavy traffic and numerous utilities throughout OU 3 will be addressed at the time of system installation. In addition, pavement overlying both groundwater plume areas at Area C and the downgradient plume at Area D is very thick to accommodate aircraft traffic. Prior to installing boreholes for HRC™ injection at those areas, coring through the thick, high-strength concrete will be necessary, and the boreholes must be refilled using the same grade of concrete after injection. Contaminated groundwater at Area C lies beneath an aircraft taxiway, and therefore system installation may interfere with ongoing flightline operation. Construction activities at Area C will require coordination with the NAS Jacksonville flightline control tower. Equipment required for groundwater monitoring is easily obtained. Groundwater monitoring, groundwater use restrictions, and five-year site reviews are easily implemented.
Cost	The present worth costs of the enhanced biodegradation alternative for groundwater Area C and Area D were summarized in Tables 2-31 and 2-32, respectively. The estimated total present worth costs for the enhanced biodegradation alternative are: $819,300 for Area C, and $956,600 for Area D.
Federal and State Acceptance	The USEPA and FDEP have concurred with the selected remedy for groundwater Areas C and D.
Community Acceptance	The community has been given the opportunity to review and comment on the selected remedy for Area C and Area D. Public comment concurred with the selected remedy for Areas C and D. Comments received were addressed (see Chapter 3.0) and did not alter the selected remedies proposed in the proposed plan.

Notes: OU = operable unit.
FDEP = Florida Department of Environmental Protection.
ARAR = applicable or relevant and appropriate requirement.
USEPA = U.S. Environmental Protection Agency.
PSC = potential source of contamination.
HRC™ = hydrogen release compound.
VOC = volatile organic compound.
RAO = remedial action objective.
DPT = direct-push technology.
NAS = Naval Air Station.

Table 2-39
Comparison of Selected Groundwater Remedy for Area F with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Overall Protection of Human Health and the Environment	The risk assessment for OU 3 predicted unacceptable risk to human health under future groundwater use assumptions (adult occupational worker). The chemical oxidation alternative will provide protection to future human receptors who may use OU 3 groundwater as a potable water supply. Humans will be protected in the short term because groundwater use restrictions will prohibit the consumption of groundwater until complete aquifer restoration (i.e., when action levels are achieved). The chemical oxidation process will eventually reduce VOC concentrations in groundwater. The combination of in situ groundwater treatment and implementation of groundwater-use restrictions will ensure that human health is properly protected in both the short- and long-term. By implementing this alternative, no adverse short-term or cross-media effects are anticipated.
Compliance with ARARs	At Area F, the only compounds in groundwater detected at concentrations exceeding ARARs are VOCs (refer to Table 2-20). It is expected that implementation of the chemical oxidation alternative will comply with chemical-specific ARARs for VOCs. Annual groundwater monitoring is incorporated to ensure compliance with chemical-specific ARARs. The chemical oxidation alternative will also comply with location- and action-specific ARARs.
Long-term Effectiveness	This alternative offers a long-term and permanent remedy for VOC contamination in groundwater. Chemical oxidation has been proven effective for the destruction of chlorinated solvents in groundwater. A treatability study will be required to establish site-specific performance and design parameters, including oxidant dosing, prior to implementing this remedial technology. Groundwater use restrictions will prevent human consumption of groundwater until the action levels for VOCs are achieved, and the potential risk to future occupational workers is eliminated. Groundwater monitoring will provide a means of evaluating the concentrations of contaminants in groundwater over time.
Reduction of Toxicity, Mobility, and Volume	This alternative will reduce the toxicity, mobility, and volume of VOCs in the groundwater at Area F. This will be accomplished through the chemical destruction of VOCs in situ by chemical oxidation. The estimated mass of VOC contamination at Area F is 4.0 kg. The only residuals produced by implementation of this alternative at Area F will be the bag filters. The filters screen out any silt extracted with the groundwater and manganese dioxide (MnO_2) particles which form as a result of the oxidation process. The bag filters will be disposed as appropriate.

See notes at end of table.

Table 2-39 (Continued)
Comparison of Selected Groundwater Remedy for Area F
with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Short-term Effectiveness	This remedial alternative will achieve the action levels for groundwater by treatment of the VOCs using in situ chemical oxidation. The treatment duration required to provide sufficient flushing of oxidant with contaminated groundwater is estimated to be 5 years at Area F. Due to the relatively short-term operation of the remedial action, groundwater use restrictions will be implemented to provide protection to potential future occupational workers from the existing contamination. There will be only slight exposure to workers performing installation of extraction and injection wells, operations and maintenance, and annual groundwater monitoring. These activities will not pose a significant risk to workers or the community.
Implementability	Construction of a chemical oxidation treatment system is relatively easy to implement using a modular oxidant feed system. System operation will require close monitoring of oxidant usage, and exchange of full drums of $KMnO_4$ to the drum inverter system when necessary. Heavy traffic and numerous utilities throughout OU 3 will be addressed at the time of system installation. Equipment required for groundwater and system monitoring is easily obtained. Groundwater and treatment system monitoring, groundwater use restrictions, and five-year site reviews are easily implemented.
Cost	The present worth cost of the chemical oxidation alternative for groundwater at Area F was summarized in Table 2-33. The total present worth estimated costs for implementation of the chemical oxidation alternative is $1,178,300 for Area F.
Federal and State Acceptance	The USEPA and FDEP have concurred with the selected remedy for Area F.
Community Acceptance	The community has been given the opportunity to review and comment on the selected remedy for Area F and the public agreed with the selected remedy for Area F. Comments received were addressed (see Chapter 3.0) and did not alter the selected remedies proposed in the proposed plan.

Notes: OU = operable unit.
ARAR = applicable or relevant and appropriate requirement.
FDEP = Florida Department of Environmental Protection.
USEPA = U.S. Environmental Protection Agency.
PSC = potential source of contamination.
VOC = volatile organic compound.
kg = kilogram.
$KMnO_4$ = potassium permanganate.

Table 2-40
Comparison of Selected Groundwater Remedy for Area B and Area G with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Overall Protection of Human Health and the Environment	The risk assessment for OU 3 predicted unacceptable risk to human health under future groundwater use assumptions (adult occupational worker). The MNA alternative will provide a minimum standard of protection to future human receptors who may use OU 3 groundwater as a potable water supply. Humans will be protected during the treatment period by implementing groundwater use restrictions which will prevent anyone from developing a drinking water well within the shallow zone of the surficial aquifer at OU 3 until restoration is complete (i.e., when action levels are achieved). The MNA process will eventually reduce the VOC concentrations in groundwater. The combination of in situ groundwater treatment and implementation of groundwater use restrictions will ensure that human health is properly protected in both the short- and long-term. By implementing this alternative, no adverse short-term or cross-media effects are anticipated.
Compliance with ARARs	At Areas B and G, the only compounds in groundwater detected at concentrations exceeding ARARs are VOCs (refer to Table 2-20). The MNA alternative will not comply with chemical-specific ARARs (i.e., Federal MCLs and Florida drinking water standards) in the short-term. However, this alternative will eventually comply with ARARs when natural physical, chemical, and biological processes in the aquifer reduce contaminant concentrations over time. Groundwater monitoring will be used to assess degradation of the chlorinated solvents in groundwater and evaluate compliance with ARARs. The MNA alternative will not trigger either location-specific or action-specific ARARs.
Long-term Effectiveness	This alternative offers a long-term and permanent remedy for VOC contamination in groundwater. MNA is a proven technology for biologically destroying chlorinated solvents over time and should be effective at Areas B and G, especially since ongoing natural attenuation has been observed at OU 3 (ABB-ES, 1998). Groundwater monitoring will provide a means of evaluating the concentrations of VOCs in groundwater and assessing the degradation rate of contaminants. In addition, monitoring of indicator parameters within the aquifer will help to evaluate the effectiveness of natural attenuation in reducing VOC concentrations. Administrative actions proposed in this alternative will provide a means of exposure control, but will not provide a permanent, irreversible remedy for risks posed by groundwater contamination. Groundwater monitoring and administrative actions are considered reliable controls.
Reduction of Toxicity, Mobility, and Volume	Although no active treatment is included in this alternative, contaminant toxicity of VOCs will be reduced over time through natural degradation processes. The alternative will not provide a reduction in contaminant mobility or volume; however, the estimated treatment duration for Areas B and G is shorter than the estimated travel time for the contaminated groundwater to migrate to a receiving water body, i.e., the St. Johns River (ABB-ES, 1998). USGS groundwater modeling for OU 3 indicated that groundwater from Area G will be treated (reduce VOC concentrations to action levels) by MNA within 39 years, whereas the estimated travel time to the St. Johns River for contaminated groundwater is estimated to be 150 years (for TCE). Even though the USGS modeling has not calculated the VOC decay timeframe for Area B, the model has determined that all the contaminated groundwater will be in the clay plug within 41 years. It is estimated that it will take at least 200 years for the water to pass through the clay during which time decay of the VOCs will occur. No treatment residuals are produced by implementation of this alternative.

See notes at end of table.

Table 2-40 (Continued)
Comparison of Selected Groundwater Remedy for Area B and Area G with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Short-term Effectiveness	This alternative will not comply with action levels in the short-term because the only means of contaminant reduction posed by this alternative is natural attenuation or biological decay. The MNA alternative will eventually reduce human health risks posed by groundwater contamination because natural biodegradation will reduce the concentration of VOCs in groundwater. The implementation of groundwater use restrictions will provide additional protection of human health. This alternative poses only a minimum threat to site workers through exposure to contaminated groundwater during monitoring activities. Other than well installation, remedial construction activities are not proposed under this alternative. These activities will not pose a risk to the community.
Implementability	The MNA alternative does not require construction activities for implementation, other than installation of monitoring wells. Monitoring wells have previously been installed at Areas B and G with no difficulty. Monitoring equipment is easily obtained, and groundwater monitoring and modeling, five-year site reviews, and groundwater use restrictions are easily implemented.
Cost	The present worth costs of the MNA alternative for groundwater at Area B and Area G were summarized in Tables 2-34 and 2-35, respectively. The estimated total present worth costs for implementation of the MNA alternative is $462,000 for Area B and $581,900 for Area G.
Federal and State Acceptance	The USEPA and FDEP have concurred with the selected remedy for Area B and Area G.
Community Acceptance	The community recommended MNA for Area G (see Chapter 3.0) and, therefore, concurs with the selected remedy. For Area B, the community recommended the no action alternative which includes groundwater monitoring. FDEP's modification of sampling requirements (i.e., addition of natural attenuation parameters) does not significantly change the preferred alternative and, therefore, is acceptable to the community.

Notes: USEPA = U.S. Environmental Protection Agency.
FDEP = Florida Department of Environmental Protection.
MNA = monitored natural attenuation.
OU = Operable Unit.
VOC = volatile organic compound.
PSC = Potential Source of Contamination.
ARARs = applicable or relevant and appropriate requirements.
MCLs = maximum contaminants levels.
TCE = trichloroethene.
USGS = U.S. Geological Survey.
ABB-ES = ABB Environmental Services, Inc.

Table 2-41
Comparison of Selected Sediment Remedy with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Overall Protection of Human Health and the Environment	The ERA for OU 3 predicted unacceptable risks to ecological receptors based on exposure to PAHs and lead in the sediment adjacent to the PSC 16 outfall. Because it is believed that the contaminants are primarily contained within tar balls observed in the sediment, this alternative is expected to mitigate the assumed source of contaminants that are toxic to ecological receptors.
Compliance with ARARs	This alternative is expected to comply with ARARs by removing the suspected source (i.e., tar balls) of PAHs and lead causing toxicity to ecological receptors.
Long-term Effectiveness	There is no suspected ongoing source of PAHs and metals contamination in the sediment adjacent to the PSC 16 outfall. The tar balls may have formed as a result of a historical release of hydrocarbons. Manually raking the OU 3 sediment to remove tar balls is expected to be a permanent remedy. However, a petroleum odor, sheen, and streaks of petroleum-saturated substrate were observed in sediment sample U3-SD-11 collected in January 1999. A slight petroleum odor and sheen were also noted in sediment sample U3-SD-12, collected on the same date. During the depositional characterization of the PSC 16 outfall in April 1999, a tar ball was observed at the approximate location of sediment sample U3-SD-11. Survivorship in the toxicity test conducted on sediment sample U3-SD-11 was 0 percent, while survival in sample U3-SD-12 was 95%. Based on the observance of odor and a sheen in two samples with such opposing toxicity test results, it is difficult to definitively conclude whether selective removal of tar balls will address residual risks that may be present in sediment at the site. Final disposal of the removed tar balls at an approved off-site landfill is considered a permanent remedy. Based on sediment sampling conducted in the St. Johns River by FDEP and Mote Marine (FDEP, 1994b), PAHs and several metals, including lead, have been detected both upgradient and downgradient of OU 3. Although this alternative addresses contaminants believed to be the result of a historical release from OU 3, numerous other industrial facilities and storm water outfalls are located along the St. Johns River; therefore, it is not possible with the data available to assess whether or not upgradient sources in the river may recontaminate the PSC 16 outfall area over time.
Reduction of Toxicity, Mobility, and Volume	Raking to remove tar balls will reduce the toxicity, mobility, and volume of the contaminants in OU 3 sediment through a removal action and subsequent disposal. It is assumed that the extracted tar balls could be placed in one 55-gallon drum for disposal.

See notes at end of table.

Table 2-41 (Continued)
Comparison of Selected Sediment Remedy with Nine Evaluation Criteria

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Evaluation Criteria	Assessment
Short-term Effectiveness	This alternative could be implemented in a short amount of time, quickly eliminating the suspected source of contaminants that are toxic to ecological receptors (i.e., tar balls). The HHRA for OU 3 did not evaluate exposure to sediment. According to USEPA guidance it was not necessary since an assessment of exposure to surface water could be made for OU 3. The HHRA did not predict risks for human exposure to surface water. Therefore, there are no known health and safety concerns for site workers during implementation of this alternative. Raking the sediment will temporarily disturb the benthic aquatic organisms within the boundary of the remediation. It is anticipated, however, that aquatic receptors will readjust once remediation is complete. Bivalves were found in sediment collected during the April 1998 and January 1999 sampling events. The bivalves are large enough to be extracted by the raking device, but they will be returned to the river.
Implementability	The initial analytical and toxicity testing to confirm the limits of the tar ball removal action is easily performed using a ponar dredge from a small boat. The water depth in the proposed remedial area is shallow (approximately 1.5 to 3 feet), which would facilitate raking either manually by wading workers with a raking device or from a small boat. The extracted tar balls will be collected and containerized in a drum for disposal. This alternative will not require delivery of any large equipment to the site. Access to the area is restricted, however, and will require coordination with NAS Jacksonville personnel.
Cost	The present worth cost of the selective tar ball removal alternative for the OU 3 sediment was summarized in Table 2-36. The present worth of this alternative is estimated to be $79,900.
Federal and State Acceptance	The USEPA and FDEP have concurred with selected remedy.
Community Acceptance	The community has been given the opportunity to review and comment on the selected remedy. Public comment concurred with raking and removal of tar balls as the selected remedy. Comments received were addressed (see Chapter 3.0) and did not alter the selected remedy proposed in the proposed plan.

Notes: OU = operable unit.
ARAR = applicable or relevant and appropriate requirement.
FDEP = Florida Department of Environmental Protection.
USEPA = U.S. Environmental Protection Agency.
% = percent.
HHRA = human health risk assessment.
NAS = Naval Air Station.
PSC = potential source of contamination.
ERA = ecological risk assessment.
PAHs = polycyclic aromatic hydrocarbons.

Table 2-42
Description of ARARs for the Selected Remedies

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
Federal ARARs			
Clean Air Act (CAA), National Emission Standards for Hazardous Air Pollutants (40 Code of Federal Regulations. [CFR] Part 61)	Regulates specific sources of pollution. Requires these sources to meet emission standards based on maximum available control technology.	Although these requirements are not generally applicable to CERCLA activities since the sources regulated are not present, the emission limitations for certain pollutants (e.g., PCE) may be considered if a treatment process generates any air emissions.	Chemical-specific
CAA, National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50)	This rule contains emission standards, promulgated to attain the National Ambient Air Quality Standards for hazardous air pollutants.	Emission standards and monitoring requirements in this rule are relevant and appropriate requirements for remedial alternatives that involve the discharge of pollutants to the air (e.g., air stripping). The State of Florida has jurisdiction over the implementation of these regulations through the State Implementation Plan.	Chemical-specific
Clean Water Act (CWA), General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR Part 403)	Regulations for the introduction of pollutants from nondomestic sources into wastewater treatment plants (either Publicly or Federally Owned Treatment Works [POTW or FOTW]) to control pollutants that pass through, cause interference, or are otherwise incompatible with treatment processes at the plant.	If extracted and treated groundwater is discharged to a POTW or FOTW, the discharge must meet local limits imposed by the plant.	Action-specific
CWA, National Permit Discharge Elimination System (NPDES) (40 CFR Part 122 and 125)	Requires permits far discharge of any pollutant into the navigable waters of the United States. Permits specify allowable concentrations of contaminants that may be present in the effluent stream.	Because Naval Air Station Jacksonville Is a CERCLA site, only the substantive requirements of attaining a NPDES permit is required for remedial alternatives that involve discharging pollutants to navigable waters.	Action-specific
CWA, Water Quality Standards (40 CFR Part 131)	Ambient Water Quality Criteria (AWQC), which are non-enforceable, ecological- and human health-based criteria, have been developed to establish water quality standards under the CWA.	Remedial actions that involve the discharge of groundwater to a surface water body must consider the Federal AWQC in the absence of a state surface water standard.	Chemical-specific
Endangered Species Act Regulations (50 CFR Parts 81, 225, 402)	The Act requires Federal agencies to take action to avoid jeopardizing the continued existence of federally listed endangered or threatened species.	Endangered or threatened species may be present in the vicinity of Operable Unit (OU) 3. If a planned remedial action could potentially affect an endangered species, this regulation will apply.	Location-specific

See notes at end of table.

Table 2-42 (Continued)
Description of ARARs for the Selected Remedies

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
Federal ARARs (Continued)			
National Environmental Policy Act Wetlands, Floodplains, Important Farmland, Coastal Zones, etc. (40 CFR Part 6)	Appendix A sets forth the policy for carrying out the Floodplains Executive Order 11988. This appendix requires cleanup in a floodplain not be selected unless determination is made that no practicable alternative exists.	If a remedial action will be Implemented in a designated floodplain, alternatives should be considered to reduce the risk of flood loss and preserve and restore floodplains.	Location-specific
Resource Conservation and Recovery Act (RCRA) Regulations, Identification and Listing of Hazardous Wastes (40 CFR Part 261)	Defines listed and characteristic hazardous wastes subject to RCRA. Appendix II contains the Toxicity Characteristic Leaching Procedure.	Based on the history of operations at OU 3 and the solvents used during operations, any investigative-derived waste would be analyzed and classified prior to disposal.	Chemical-specific Action-specific
RCRA Regulations, Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263)	These regulations establish procedures to be followed when transporting manifested hazardous waste within the United States.	If a remedial alternative for OU 3 includes the offsite transportation of hazardous waste for treatment and/or disposal, transporters must meet these requirements.	Action-specific
RCRA Regulations, Releases from Solid Waste Management Units (SWMUs) (40 CFR Part 264, Subpart F	This rule establishes the requirements for SWMUs, and encompasses groundwater protection standards, concentration limits, point of compliance, compliance period, and requirements for groundwater monitoring.	The rule is relevant and appropriate for CERCLA sites contaminated with RCRA hazardous constituents.	Action-specific
RCRA Regulations, Corrective Action for Solid Waste Management Units (40 CFR Part 264, Subpart S)	This rule establishes corrective action management units (CAMUs) and temporary units (TUs) as two options for corrective action. CAMUs are areas within a permitted facility that may be designed for the management of remediation of hazardous wastes without triggering the Land Disposal Restrictions (LDRs) or minimum technical requirements. TUs are tanks or containers used to store or treat remedial wastes for up to 1 year without triggering LDRs.	This rule is a potential ARAR if an onsite remedial action is chosen for an area of contamination. The designation of a CAMU or TU should be considered as an option in managing hazardous wastes at the OU during the Feasibility Study (FS).	Action-specific
RCRA Regulations, LDRs (40 CFR Part 268)	This regulation establishes restrictions on land disposal of untreated hazardous wastes and provides standards for treatment of hazardous waste prior to land disposal.	Any investigative-derived wastes generated as a result of remedial actions would be analyzed and characterized prior to disposal. Remedial alternatives that generate a wastestream requiring offsite disposal (e.g., spent carbon filters or exchange resins from treatment of extracted groundwater) will need to achieve the LDRs.	Action-specific

See notes at end of table.

Table 2-42 (Continued)
Description of ARARs for the Selected Remedies

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
Federal ARARs (Continued)			
RCRA Regulations, LDRs for Contaminated Debris (40 CFR Parts 270 and 271)	Hazardous debris, under these regulations, can be managed so that treated, cleaned debris may be disposed as non-hazardous waste. Treatment residuals containing the original contaminant remain a hazardous waste and must be disposed as such.	If a remedial alternative for OU 3 generates hazardous debris (e.g., if pavement or concrete contaminated with hazardous waste requires removal), these regulations will apply to disposal and/or treatment of that debris.	Action-specific
Safe Drinking Water Act (SDWA) Regulations, Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) (40 CFR Part 141, Subparts B and F)	Establishes enforceable standards (MCLs) for potable water for specific contaminants that have been determined to adversely affect human health. MCLGs are nonenforceable health goals established by USEPA.	MCLs can be used for groundwater or surface waters that are current or potential drinking water sources. Non-zero MCLGs can be considered potential relevant and appropriate requirements for groundwater used as a current or potential drinking water source.	Chemical-specific
SDWA Regulations, Underground Injection Control Program (40 CFR Parts 144, 146, 147, and 1000)	These regulations outline minimum program and performance standards for underground injection programs.	If a remedial alternative for OU 3 includes injection into the aquifer, then these regulations will apply.	Action-specific
Federal Guidance Material			
National Oceanographic and Atmospheric Administration Sediment Threshold Values	This guidance document contains biological effects-based criteria for evaluating sediment contaminant data.	The chemical-specific sediment values provided in this guidance are TBC values when evaluating sediment in the risk assessment and the FS.	TBC
USEPA Region III Risk-Based Concentration Tables	This table contains reference doses and carcinogenic potency slopes for nearly 600 chemicals. These toxicity constants have been combined with standard exposure scenarios to calculate chemical concentrations corresponding to fixed levels of risk.	The chemical-specific soil and groundwater values provided in this guidance are TBC values when evaluating these media in the risk assessment and the FS.	TBC
USEPA Sediment Quality Criteria (SQC)	USEPA has developed and published SQC for several hydrophobic organic compounds to protect benthic organisms.	The chemical-specific sediment values provided in this guidance are TBC values when evaluating sediment in the risk assessment and the FS.	TBC

See notes at end of table.

Table 2-42 (Continued)
Description of ARARs for the Selected Remedies

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
State ARARs			
Florida Rules on Permits (Chapter 62-4, Florida Administrative Code [FAC])	Provides permitting requirements for water pollution sources and air emissions units.	The regulation will apply to offsite CERCLA activities requiring air emissions or water discharge permits.	Action-specific
Florida Surface Water Quality Standards (Chapter 62-302, FAC)	Rule distinguishes surface water into five classes based on designated uses and establishes ambient water quality standards (called Florida Water Quality Standards) for listed pollutants.	Because these standards are specifically tailored to Florida waters, they should be used to establish cleanup levels rather than the Federal Ambient Water Quality Criteria.	Chemical-specific
Florida Groundwater Classes, Standards and Exemptions (Chapter 62-520, FAC)	Rule designates the groundwater of the State into five classes and establishes minimum "free from" criteria. Rule also specifies that class I & II waters must meet the primary and secondary drinking water standards listed In Chapter 62-550, FAC.	These regulations should be used when determining cleanup levels for groundwater.	Chemical-specific
Florida Underground Injection Control Regulatlons (Chapter 62-522, FAC)	This rule establishes a State underground injection control program consistent with the Federal requirements and appropriate to the hydrogeology of Florida. Five classes of injection wells are defined.	If a remedial alternative for OU 3 includes injection into the aquifer, then these regulations will apply.	Action-specific
Florida Drinking Water Standards (Chapter 62-550, FAC)	Rule adopts Federal primary and secondary drinking water standards and also creates additional rules to fulfill State and Federal requirements for community water distribution systems.	The standards provided in this rule will be used when evaluating cleanup levels for groundwater at OU3.	Chemical-specific
Florida Wastewater Facility Permits (Chapter 62-620, FAC)	Establishes requirements for wastewater permits. Because Florida is a designated state (i.e., has the authority to implement the National Pollutant Discharge Elimination System permits), one permit will suffice to meet both Federal and State discharge requirements.	If a remedial alternatives consists of the discharge of wastewater to navigable waters, the substantive requirements of this rule will need to be achieved.	Action-specific
Pretreatment Requirements for Existing and New Sources of Pollution (Chapter 62-625, FAC)	Rule establishes the authority of various bodies to implement pretreatment standards to control pollutants that pass through or interfere with treatment processes In domestic wastewater facilities.	The regulation will apply to remedial activities involving the discharge of remediation waters to a POTW or FOTW.	Chemical-specific

See notes at end of table.

Table 2-42 (Continued)
Description of ARARs for the Selected Remedies

Record of Decision
PSCs 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas
of Elevated Groundwater Contamination, Operable Unit 3
Naval Air Station Jacksonville
Jacksonville, Florida

Name and Regulatory Citation	Description	Consideration in the Remedial Action Process for Operable Unit 3	Type
State ARARs (Continued)			
Florida Water Quality Based Effluent Limitations (WQBELs) (Chapter 62-650, FAC)	Requires that all activities and discharges, except dredge and fill, must meet effluent limitations based on technology or water quality. WQBELs are determined by FDEP based on the characteristics of the receiving water, and the surface water criteria promulgated by FDEP.	The regulation will apply to remedial alternatives that discharge contaminated groundwater to surface water.	Chemical-specific
Hazardous Waste Rules (Chapter 62-730, FAC)	These rules adopt by reference appropriate sections of 40 CFR Parts 260 through 268 and established minor additions and exceptions to these regulations concerning the generation, storage, treatment, transportation, and disposal of hazardous waste.	Based on the history of operations at OU 3 and the solvents used during operations, any investigative-derived waste would be analyzed and classified prior to disposal.	Action-specific
State Guidance Materials			
Approach to the Assessment of Sediment Quality in Florida Coastal Waters	Recommends effects-based sediment quality assessments.	These guidelines will be considered when conducting the ecological risk assessment and in establishing remedial action objectives for sediment at the site.	TBC
Groundwater Guidance Concentrations, Bureau of Groundwater Protection	The document provides maximum concentration levels of contaminants for groundwater in the State of Florida. Groundwater with concentrations less than the listed values are considered "free from" contamination.	The values in this guidance should be considered when determining cleanup levels for groundwater.	TBC
Soil Cleanup Goals for Florida	Provides maximum concentration levels of contaminants for soil in the State of Florida. Includes levels for residential, industrial, and leaching exposure scenarios.	The values in this guidance should be considered when determining cleanup levels for soil.	TBC

Notes:
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
USEPA = U.S. Environmental Protection Agency
TBC = to be considered.
FDEP = Florida Department of Environmental Protection.
PCE = tetrachloroethene.
ARAR = applicable or relevant and appropriate requirement.

First, for Area G, implementation of chemical oxidation has been changed to MNA with minor modifications from what was presented in the RI/FS. FDEP requested that sampling be performed semi-annually for 2 years, annually for the next 3 years, then biannually through year 39. This change has resulted in a slight decrease in the estimated total cost.

Second, for Area B, implementation of enhanced bioremediation has been changed to MNA with the same sampling schedule as Area G (through year 41). MNA was not evaluated for Area B in the RI/FS; however, the no action alternative did include 30 years of groundwater monitoring for VOCs. Therefore, Area B's no action alternative, preferred by the community, and FDEP's requested MNA sampling program differ in number and type of parameters analyzed and total duration (30 years versus 41).

3.0 RESPONSIVENESS SUMMARY

The Responsiveness Summary serves three purposes. First, it provides regulatory agencies with information about the community preferences regarding the remedial alternatives presented for storm sewer water, groundwater, and sediment and for PSCs 11, 12, 13, 14, and 15 at OU 3, NAS Jacksonville. Second, the Responsiveness Summary documents how public comments have been considered and integrated into the decision-making process. Third, it provides the Navy, USEPA, and FDEP with the opportunity to respond to each comment submitted.

The RI/FS and the Proposed Plan for OU 3 were made available in an information repository maintained at the Charles D. Webb Wesconnett Branch of the Jacksonville Public Library.

One written comment was received during the public comment period and oral comments and input were received during the Public Meeting/RAB meeting held May 16, 2000.

3.1 STAKEHOLDER COMMENTS AND LEAD AGENCY RESPONSES. A RAB member, Curtis McLemore, submitted a written comment, as follows:

> "My comments pertaining to plan of cleanup of hazardous waste sites within (OU 3) are in agreement of the decision of the RAB members..." (sic).

The comments and input provided during the Public Meeting/RAB meeting are as follows:

Area B: The RAB supports "No Action" for Area B. Enhanced biodegradation, extraction and treatment, and chemical oxidation are unacceptable for this site.

Area C: The RAB supports "Enhanced Biodegradation" for Area C. No action and extraction and treatment are unacceptable for this site.

Area D: The RAB supports "Enhanced Biodegradation" for Area D. In addition, 4 of 5 RAB members said that no action would also be appropriate. Only extraction and treatment was considered unacceptable for this site.

Area F: The RAB supports "Chemical Oxidation" for Area F. No action, natural attenuation, and air sparging are unacceptable for this site.

Area G: The RAB supports "Natural Attenuation" for Area G. No action, air sparging, and chemical-oxidation are unacceptable for this site.

PSC 16: The RAB supports "Selective Removal of Tar Balls" for PSC 16. No action and dredging are unacceptable for this site.

Storm Sewer Water: The RAB supports delaying action on the storm sewer water until after remediation is complete at Area F. If remediation at Area F does not concurrently remediate VOCs in the storm sewer water, then CIPP is recommended. No action for this site is unacceptable.

FDEP and USEPA recognize the effort put forth by the RAB and appreciate their input to this critical process. Two of the preferences expressed by the RAB are different from the preferred remedial alternatives as discussed in the Proposed Plan and this ROD. The two areas of disagreement are Area B and Area G. In summary, at Area B where FDEP and USEPA prefer enhanced biodegradation, the RAB prefers no action. At Area G, where FDEP and USEPA prefer chemical oxidation, the RAB prefers natural attenuation.

Both agencies have taken these comments under serious consideration and have concluded that the public's opinions concerning Areas B and G are valid. In response, FDEP issued a letter dated July 12, 2000, stating they concur with the preference for MNA at Area G. The no action alternative for Area B, as outlined in the FS, includes a long-term monitoring program. FDEP concurs with the long-term monitoring program at Area B; however, the agency prefers implementation of an MNA program which will comply with ARARs and also demonstrate to FDEP that groundwater remediation is taking place. USEPA concurs with the changes in the selected remedies for Areas B and G.

3.2 TECHNICAL AND LEGAL ISSUES. No technical or legal issues have been brought forward by the community or other governmental agencies.

REFERENCES

ABB Environmental Services, Inc. (ABB-ES). 1992a. *Sampling Event No. 6 Installation Restoration Program MILCON P615 Site Sampling, Naval Air Station, Jacksonville, Florida.* Prepared for Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), North Charleston, South Carolina (July).

ABB-ES. 1992b. *Building 780 Construction Site, Health Threat Evaluation, Naval Air Station, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (October).

ABB-ES. 1993a. *Sampling Event No. 15 Potential Source of Contamination Site P-159, Naval Air Station, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM), North Charleston, South Carolina (June).

ABB-ES. 1993b. *Sampling Event No. 16 Potential Source of Contamination Building 101 Underground Storage Tanks, Naval Air Station, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM), North Charleston, South Carolina (June).

ABB-ES. 1995a. *Naval Installation Restoration Program Plan, Volume 7, Remedial Investigation and Feasibility Study Work and Project Management Plan, Operable Unit (OU 3), Naval Air Station (NAS), Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (March).

ABB-ES. 1995b. *Engineering Evaluation and Cost Analysis, Buildings 106 and 780 at Operable Unit 3, NAS Jacksonville.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (August).

ABB-ES. 1995c. *Certification and Closure Report and Comprehensive Environmental Response, Compensation, and Liability Act Soil Contamination Reduction Building 101, Naval Aviation Depot's Former Plating Shop, Naval Air Station (NAS), Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (November).

ABB-ES. 1996. *Remedial Investigation and Feasibility Study, Operable Unit 1, Naval Air Station Jacksonville, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (March).

ABB-ES. 1997. *Addendum No. 2, Final Design for Building 106 and 780, Naval Air Station (NAS), Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (June).

ABB-ES. 1998. *Engineering Evaluation of Areas with Elevated Groundwater Contamination, Operable Unit 3, Naval Air Station (NAS), Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (March)

Bechtel Environmental, Inc. (BEI). 1995. *PSC 13 Final Radiological Survey Report for the NAS Jacksonville, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (September).

REFERENCES (Continued)

BEI. 1996. *Remedial Work Plan for Interim Removal Action, Buildings 106 and 780 at OU 3, Naval Air Station Jacksonville, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (August).

BEI. 1998. *PSC 15, Final Radiological Survey Report for Completion of Remediation Activities at the Naval Air Station, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (January).

Davis, H. J., 1998, *Ground-Water Hydrology and Simulation of Ground-Water Flow at Operable Unit 3 and Surrounding Region, U.S. Naval Air Station, Jacksonville, Florida:* U. S. Geological Survey Open File Report 98-68, 36p.

Environmental Remediation Services, Inc., 1993, *Environmental Health Sampling at Albemarle and Wasp Street Utility Construction Site, Naval Air Station, Jacksonville, Florida.* Prepared for Navy Public Works Center (January).

Florida Department of Environmental Protection (FDEP). 1994a. Florida Ground Water Guidance Concentrations. Division of Water Facilities, Bureau of Groundwater Protection. Tallahassee, Florida (June).

FDEP. 1994b. *Florida Coastal Sediment Contaminants Atlas: A Summary of Coastal Sediment Quality Surveys.*

Florida Game and Freshwater Fish Commission (FGFFC). 1997. Letter from the FGFFC regarding the presence of rare, threatened, or endangered species at OU 3, Jacksonville, Florida (September).

Florida Legislature, 1996, Surface Water Quality Standards, Chapter 62-302, FAC. Tallahassee, Florida (December 26).

Florida Natural Areas Inventory (FNAI). 1997. Letter from the FNAI regarding the presence of rare, threatened, or endangered species at Mulberry Cove, Jacksonville, Florida (September).

Fred C. Hart Associates, Inc. 1983. *Initial Assessment Study, NAS Jacksonville, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (March)

Geraghty & Miller, Inc. 1985a. *Results of Sediment Sampling at Plating and Cleaning Shop, Building 101, Naval Air Station (NAS) Jacksonville.* Prepared for Southern Division, Naval Facilities Engineering Command (November).

Geraghty & Miller, Inc. 1985b. *Verification Study, Assessment of Potential Groundwater Pollution at NAS Jacksonville, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (December)

Geraghty & Miller, Inc. 1986. *Characterization Phase Assessment of Ground-Water Contamination at Naval Air Station, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM (March).

Geraghty & Miller, Inc. 1988. *Findings from the Subsurface Investigation at Wright Street, Naval Air Station, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM (February).

Geraghty & Miller, Inc. 1989. *Contamination Assessment of Building 795, the Addition, Naval Air Station, Jacksonville, Florida.* Prepared for Southern Division, Naval Facilities Engineering Command (February).

Geraghty & Miller, Inc. 1990. *Technical Memorandum No. 1, Sampling Event Report No. 1, Building 780 Area: Subsoil and Groundwater, Naval Air Station, Jacksonville, Florida.* Prepared for Southern Division, Naval Facilities Engineering Command (July).

Harding Lawson Associates (HLA). 1998a. *Sampling Event Report, Potential Source of Contamination 12, Old Test Cell Building.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (February)

HLA. 1998b. *Sampling Event Report, Potential Source of Contamination 14, Battery Shop.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (February).

HLA. 1999a. *Interim Remedial Action Operations Report for Building 106, Naval Air Station Jacksonville, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (June).

HLA. 1999b. *Interim Remedial Action Startup Activities Report for Building 780, Naval Air Station Jacksonville, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (June).

HLA 2000a. *Remedial Investigation and Feasibility Study, Operable Unit 3, Naval Air Station Jacksonville, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (April).

HLA 2000b. *Proposed Plan for Remedial Action, Naval Air Station Jacksonville, Operable Unit 3, Potential Sources of Contamination 11, 12, 13, 14, 15, 16, and 48, Building 780, and Other Areas of Elevated Groundwater Contamination, Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (April).

Radiological Affairs Support Office. 1995. *Navy Sea Systems Command Detachment, Department of the Navy. Review of Remediation and Final Radiological Survey of PSC 13, NAS Jacksonville.* Memorandum 5104/62467/00207, RON:952430, Ser:02/02F/0151, from D. E. Farrand to Commanding Officer, NAS Jacksonville.

Regenesis, HRC Technical Bulletin # 3.1.2: HRC Study in a Single Well in Florida, and HRC Technical Bulletin # 3.1.3: HRC Field Demonstration in WI, www.regenesis.com.

Robert Bates and Associates, Inc. 1988. *Utility Technical Study (UTS) 100% Report, Evaluation of Storm Water Drainage System, Cross Connections in the NADEP Area: NAS Jacksonville, Florida.* Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina (July).

United States Environmental Protection Agency (USEPA). 1995. Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment (November).

USEPA. 1996. Drinking Water Regulations and Health Advisories. Office of Water. Washington, D.C. (October).

USEPA. 1999. USEPA Region III Risk-Based Concentration Table, USEPA Region III (April).

USEPA, FDEP, and Department of Navy Environmental Program, 1998. Land Use Controls, Signing Ceremony; August 31.

Water and Air Research and others. 1982. *Hazardous Waste Survey, Naval Air Station Jacksonville.* Prepared for Southern Division, Naval Facilities Engineering Command (November).

Zheng, C. 1990. *MT3D, A Modular Three-Dimensional Transport Model for Simulation of Advection, Dispersion and Chemical Reaction of Contaminants in Groundwater System.* Version 1.5. University of Alabama.